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WATER-WORKS IMPROVEMENTS FOR PORT ELIZABETH, CAPE OF GOOD HOPE, S. A.

Port Elizabeth, South Africa, is improving its water supply at a total expense of $1,800,000. The work includes two dams, two filter plants, a considerable length of steel supply mains and a service reservoir. It is being carried out under the direction of Mr. W. Ingham, Assoc. M. Inst. C. E., M. Inst. M. E., the Hydraulic Engineer to the Municipality of Port Elizabeth. We are indebted to Mr. Ingham for photographs and for a pamphlet relating to portions of the work; particularly one of the dams and some features of pipe line construction.

The rubble concrete dam shown in the first four of our engravings is located on the Sand River, a few hundred feet below the junction with it of the Palmiet River. It will form a reservoir of about 220,000,000 U. S. gallons. The dam has a height of 50 ft. from the old river bed to the crest and of 55 ft. to the top of the parapet wall. The overflow portion is 151 ft. long and the total length of the structure *at this level* is 398 ft. The bottom width or thickness is 38 ft. The top thickness is not given. The dam is founded on hard shale, lying vertically. Besides being bonded into the rock, the dam is further protected from sliding by "a large number of 1-in. square iron rods," extending "into the solid rock and carried up 12 ins. into the dam."

The concrete was composed of 1 part Portland cement, 1½ parts sand and 5½ parts of stone broken to pass a 1¼-in. ring. In the concrete were embedded "large stones called plums or displacers." The quartzite rock weighed 167 lbs. per cu. ft., the concrete 146 lbs., and the average weight of the whole dam is 150 lbs. per cu. ft. All the "plums" were "washed and cleaned with steel brushes before" being placed and all the sand was "sieved and washed." Besides the stones "a large number of iron rods and tram-rails" were embedded in the concrete, but no particulars of size and spacing are given. The total contents of the dam is about 9,000 cu. yds.

A 2-ft. gage railway, 1½ miles long, was used to transport rubble and broken stone from the quarry. A mechanical concrete mixer was located at one end of the dam, and a traveling cableway ("'Blondin' or 'Aerial Cableway'"), with a capacity of 12½ cu. yds. per hour, was used to convey the material to place.

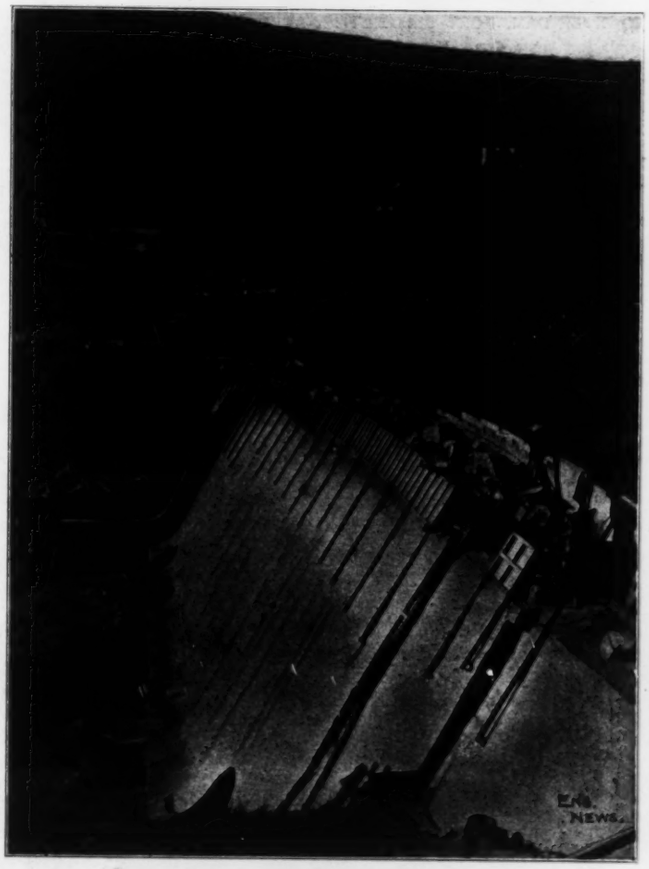
Our first view of the dam shows particularly well how the forms were used for placing the concrete; it also shows the large boulders being embedded in the concrete.

Fig. 1 shows the dam proper completed, and Fig. 2 shows it from the same general point of view, but at an earlier stage of construction, and while the culverts at either end were passing an enormous flood.

An interesting feature of the dam is the weir and weir basin, shown in Fig. 1. The weir is 100 ft. long and, with the aid of a Hutchinson discharge recorder, will measure every drop of water that wastes over the dam, or that passes through the washout pipe. This pipe enters the basin at its left (Fig. 1). Three outlet pipes, at different levels, connect with the gate house shown under construction, at the left, in Fig. 1.

A Venturi meter will be placed on the supply conduit leading from this dam.

The drainage area tributary to the Sand River dam is 20.41 sq. miles and of the Bulk River dam 11.22 sq. miles, and of this [combined area?] about 75% has been bought by the city. The estimated cost of a dam to impound only 84,000,000 (U. S.) gallons on the Sand River site was about $140,000, but the capacity has been increased to 200,000,000 (U. S.) gallons without any increase in cost. The bed of the river "is being cleared of vegetable matter as far as possible, and the sides, under water, are being ploughed and cleaned."



RUBBLE CONCRETE DAM UNDER CONSTRUCTION, PORT ELIZABETH WATER SUPPLY, CAPE OF GOOD HOPE, S. A.

A "filter plant and house" will be erected 150 yds. below the dam. An 18-in. steel pipe line will lead from the filter to the city.

The Bulk River dam, which we understand is about to be put under construction, will be 76 ft. high from stream bed to overflow level. It will impound about 145,000,000 U. S. gallons, be curved upstream with a radius of 300 ft., "and will be placed at the top of a waterfall." The natural scenery here is said to be "very fine and picturesque," and it is also stated that the dam "will add to the beauty of the scene." The upstream face of the dam "will be built of concrete blocks, while the downstream will be of quartzite obtained on the site." This statement does not make clear the composition of the body of the dam, but we infer that the whole structure will be of stone, except the upstream face.

A Venturi meter will be placed on the supply main leading from this dam.

A mechanical filter plant of the pressure type will be built below the dam, and on the supply main. The filter "is known as Candy's Automatic Air Compressing and Aerating Polarite Filter." The pamphlet states that the substitution of mechanical for "sand filters" will reduce maintenance and working expenses to £55 a year, in place of £410; also that the "bacterial purification by this system is very high, and the water is oxygenated in its passage through the filter"; all of which has an old-time, familiar sound to one whose memory runs back to the golden age of the mechanical filter promoter in America.

It appears that a large amount of steel pipe line construction is involved in these water supply improvements, some $650,000 for pipe line and for road alterations being included in the estimates, of which $425,000 has already been expended. No exact information regarding the pipe lines is at hand. Mention has already been made of an 18-in. steel main from the Sand River dam, which is all that is said under that head in the pamphlet sent us by Mr. Ingham. In another place it is stated that "the pipe line from Bulk River dam

to Green Bushes break pressure tank is 17¾ miles in length, or about 45% of the total length of the whole pipe line" [from this dam—Ed.?]. The first two miles of the 17¾ consists of pipe only 9 ins. in diameter, being a branch "from Bulk River to the main line." Then come 7.83 miles of 15¾-in., 6.2 miles of 17¼-in., and 2.5 miles of 13-in. pipe. The sizes other than the 9-in. were "designed according to the various gradients, bearing in mind the question of nesting" [for shipment from England—Ed.]. The nesting saved between £5,000 and £6,000 of freight charges.

FIG. 1. GENERAL VIEW OF SAND RIVER DAM, PORT ELIZABETH WATER SUPPLY.

(Looking up-stream. Measuring weir and basin just below dam. House for Hutchinson weir recorder and Venturi meter at left end of weir. Gate house on dam under construction.)

No information regarding grades or pressures is given, but it is stated that the 9-in. branch will deliver 900,000 (U. S.) gallons when new and 600,000 when incrusted, and the main line (13 to 17¼-in.) 2,700,000 and 1,800,000 (U. S.) gallons, respectively. The specifications called for Siemens-Martin mild steel, with physical and chemical qualities not materially different from those required of plates for steel pipe lines in this country. As is implied by the remarks on nesting, the pipes were made up before shipment. They were "tested before dipping to 400 lbs. per sq. in.," and "owing to the fact that steel rusts rather more quickly than cast iron, the pipes received two coats of coating composition [Angus Smith?—Ed.] instead of one, as usually given." No information regarding the joints is at hand, and we leave our readers to draw such inferences on that subject as they can from the views, Figs. 4 and 5, cautioning them that variations were doubtless introduced at the stream crossings shown.

Numerous kloofs [ravines?] were crossed by supporting the pipes on from one to three masonry piers (Fig. 4); on arched girders (Fig. 5) of from 20 to 30-ft. span; and on straight girder bridges of 30-ft. span (one of the latter had three such spans).

Multiple span bridges, with both straight and lattice girders, were used for river crossings, of which there were three. The size of pipe at these crossings is not stated. A tunnel 5 ft. wide, 6 ft. high and 1,132 ft. long is noted, but whether this served directly as a conduit or whether the steel pipe was laid in it is not clear.

TESTIMONY OF JOHN F. STEVENS, CHIEF ENGINEER OF THE ISTHMIAN CANAL COMMISSION BEFORE THE SENATE INVESTIGATING COMMITTEE.

From the official verbatim report of Mr. Stevens' recent testimony, we have made the following extracts containing the matter of most interest to engineers:

THE CHAIRMAN (Senator Millard).—I will ask you, Mr. Stevens, to give us, in your own way, a history of the conditions at the Isthmus as you found them when you went there and up to the present time.

MR. STEVENS.—I arrived on the Isthmus on the 26th of July last, and, of course, my first work was to look over the situation in a general way. I found a comparatively large force of men engaged in the fight against mosquitoes and filth, particularly against mosquitoes. They were draining swamps and cutting grass and weeds around the camps. They were engaged in clearing away the filth from Panama and Colon and the other smaller towns between, running hospitals, and work of that sort. Their work seemed to me then, and does yet, to be very thorough.

As far as supplies and materials were concerned, there seemed to be a decided lack of organization or lack of results. Among the most bitter complaints that I have received, particularly in my department, were as to the impossibility or the impracticability of getting materials when they were called for. And in tracing those reports and complaints down I found they largely originated from the fact that there was no supply of lumber there.

Apparently in the shipment of this lumber, which came principally from Puget Sound, they had not taken pains to ship first what was needed first. That, of course, threw the building department, which was engaged in repairing the old French houses and constructing new ones and quarters, into a little confusion, all of which it took some time to straighten out; and it has not been until the last forty or sixty days that I can say that the situation in that respect has been fully satisfactory.

With regard to other construction materials, I could not find any particular cause for complaint, taking into consideration the distance we were from supplies and the newness, you may say, of the project.

In regard to construction and engineering, about all that there was going on in the construction of the canal proper was in Culebra cut, so-called, which ex[tends] for about 8 miles after you leave the valley of the [Chagres] River. In this vicinity I found, I believe, 1[1] steam shovels working. They were new machines, fi[rst-class] in every respect. They had been bought since th[e Amer]ican régime. The balance of the equipment wi[th which] being used was the old French equipment—of w[hich] course you are all aware, there was millions of [dollars'] worth on the Isthmus, principally scrap. T[he old] equipment undoubtedly, from a continental [point] of view, twenty-five or thirty or forty years ago, [when] it was designed, was suited to the time—both the [engines] and the cars; but as far as doing economical w[ork] is concerned, I do not think I am putting it [strongly] from my point of view when I say that I would t[hrow] money and throw it into the river or put it into th[e fur]nace and burn it just as quickly as I would und[ertake] to use it in operating that plant. It is absolute[ly] unsuited for the purpose.

Of course the question of the Culebra cut is a question of the disposition of the material. In other words, there are so many million tons of freight that must be loaded, must be transported, and must be delivered to the consignee, whether the consignee is in the ocean or whether it is in a dump on the land. That is, it is a problem of transportation. Now the great advance in railroading in the last twenty years has been in the direction of heavy train loads. The only way to increase train loads is to increase the weight of your carloads and to increase the weight of your engines. These engines down there had a capacity of say 16 to 20% of the standard for economical railroading in the United States, where we handle freight cheaper than any country in the world. Another thing in regard to the construction of these engines is that they are fitted with what are called rigid wheels. You know what the result of that would be on a fairly good road—you would have lots of derailments. And these cars there, something over three thousand of them, were of very small capacity, carrying from 6 to 6½ or 7 yds. of material. They looked like an exaggerated scoop shovel set up on top of a car, higher than a man's head. They were supposed to be side dump cars. Those were the cars and that was the kind of equipment they were using.

As to the construction tracks the French laid there—we do not know how many miles of track. Every time I make an expedition out into the jungle I find a new railroad. I presume it is fair to say that they had from 200 to 250 miles of tracks laid there. They used an antiquated rail about 18 ft. long, and very poorly designed, weighing, I should say, about 62 lbs. to the yard. It is about three-quarters of an inch higher than it is wide on the base. The consequence was, particularly on tracks with no ballast, with no tie plates, and with soft ties, that those rails were continually turning over, not only on the curves, but on tangents; and the net result was that I do not think over 15% of the effective value of the steam shovels was being realized.

I could see no definite plan that these shovels were working on, excepting getting out a little material at very heavy expense; and after looking over the general situation I made up my mind that we were throwing money away. The thing to do was first to stop that waste of money in that work, and try and direct it [into] channels that would be effective at some time [in the]

FIG. 2. FLOOD PASSING THROUGH FLOOD CULVERTS OF SAND RIVER DAM, SEPTEMBER, 1905, WHILE DAM WAS UNDER CONSTRUCTION.

(View from below dam, but at higher level than view-point for Fig. 1. The rainfall for the month was 24 ins. The two 8-ft. horseshoe-shaped culverts discharged, it is said, at the rate of 2,820,000,000 (U. S.) gallons a day, at a velocity of 40 ft. per sec., or 27⅓ miles per hour.)

future tow ome well-defined plan of taking out the cut.

As soon I could determine on a general plan I started se g the French tracks which, in my opinion, could be in the final construction of the canal, taking the t out of the mud, laying new rails, putting in new t d ballasting the road; and I started grading other ks and laying them with new 70-lb. rails. That wo s continued up to this day, and since that

FIG. 3. VIEW OF SAND RIVER DAM UNDER CONSTRUCTION, SHOWING CONTRACTOR'S PLANT.

(The uppermost building on the left is the caretaker's house. The other buildings are the cement storehouse, concrete mixing house, etc.)

time I presume we have averaged from 4 to 5 and possibly 6 shovels, simply doing the grading necessary to put in these new tracks and to shape up the cut, which was left in very bad shape. We have made no effort to make what we call yardage to make a showing, but simply to get these tracks ready.

In regard to the method of doing the work and the amount of work, I found that the only equipment which had been bought was the steam shovels, with the exception of 300 Western Steel Scraper dump cars having a capacity of about 14 cu. yds. They have standard trucks, and are splendidly built cars. But they are side-dump cars, and in wet weather we found some trouble with the twenty-four new cars that had been delivered in handling the wet material. We found the same trouble that we found with the French dump cars, that they would not clear. The clay will stick to those cars.

In addition to those the Commission bought or contracted for 500 flat cars, with steel underframes and with wooden floors. Of these there were being delivered, about the time that I arrived there, 250. These were all immediately placed in the service of the Panama Railroad.

The only use that the Commission has had of them has been simply through the Panama Railroad handling its supplies. Not one of them has been used in any way in the work around the canal proper. So that in effect all of the equipment which I had for transportation was simply what I found there, and it was either a question of shutting down everything and preparing no trackage for the future or using those cars.

The double-tracking of the Panama Railroad, which I will explain later, over which the great bulk of this material must go, had been commenced, and a few of the lighter cuts had been taken out, but none of the fills had been made, on the theory—which is correct—that the fills should be made from the waste from Culebra cut. But the difficulty came here; that we had no equipment that we could run over the Panama Railroad without blocking the entire railroad. These engines, and particularly the small cars—I made several very sorrowful experiments with them—are not capable of being run over four or five miles an hour with safety on account of these rigid tracks.

They will not keep on the tracks, so that I had very largely to brought out a few moments ago, to dispose of this material, which I was absolutely obliged to take out; and the to get these tracks in, I had to take it out by the shortest haul I could and dump it in these old French dumps where there was nothing else to do with it. In fact, we got so hard up for equipment on the Panama Railroad during what is called the congestion that I made the desperate experiment of using some of these old French dump cars to haul coal in from Colon to Panama. The result was that I laid out every passenger train that I had on the road, and practically blocked the whole road for 47 miles.

What I want to emphasize is this: If I had had all the steam shovels in the world, all the money in the world, and all the men in the world, or had anybody else been there, they could not have gone on with the excavation of Culebra cut without the plant to haul the material away, because that is a transportation proposition.

I have not the exact figures as to the tonnage that the Panama Railroad is handling, excluding the Commission's supplies and material, and equipment. But they are handling a great deal more than they did ten or fifteen years ago, and they have not 10 cts. worth more equipment than they had then, when the traffic was all they could handle. That statement is broad, but it is comprehensive, and absolutely correct.

SENATOR KNOX.—Mr. Stevens, do you contemplate, when your track system is completed, for the purpose of hauling off the spoil of the excavation, that the Panama Railroad itself will be utilized in that connection?

MR. STEVENS.—Yes, sir.

SENATOR KNOX.—Then this system of roads which you are building into the Culebra cut is auxiliary to the main road? And that makes the necessity for a perfected equipment all the greater, because the main line must be used to carry this other spoil?

MR. STEVENS.—Yes, sir; and the double tracking I refer to is simply another main line to handle that enormous traffic.

SENATOR KNOX.—These lateral lines are temporary, and may be taken up and moved to other places as the work progresses, as I understand?

MR. STEVENS.—Exactly. The probabilities are, though no mortal man can make an estimate now, that there will have to be 250 or 300 miles of tracks laid during the completion of that cut, particularly if it is a sea-level canal.

Another thing that I had to consider immediately was the fact of equipment. As I say, nothing has been ordered except these 300 cars. There had been ordered a couple of dozen of two or three different kinds of dump cars, merely as a matter of experiment; and out of those two or three small orders there have been, up to the present time, twenty-four delivered of certain kinds of dump cars. I think Mr. Wallace's idea was that he would get these cars there, and then he would experiment before he made up his mind what kind of cars he wanted.

Of course that meant a very long time in getting the cars delivered, and a still longer time before the experiments could be tried; and after considering the matter thoroughly I made up my mind that during the wet season, the only car that could be used, the only car that wet material could be unloaded from, was a flat car with a plow; and I ordered 800 of them. I also ordered 120 first-class modern engines, none of which have been delivered; and none of the cars have been delivered. I also ordered plows, steam unloaders, and minor equipment of that description.

Fig. 4. Steel Pipe Line Crossing Kloof on Masonry Piers, Port Elizabeth Water-Works.

As to those 120 engines, the purchasing agent told me yesterday that he expected a few of them to be delivered in January, and that the delivery would close in June. That is about according to contract; but you understand that when an engine is delivered on the Isthmus it is delivered in pieces. We have to take it in our little shops and put it together, which means that it will probably be February before I will have the use of one of those engines. As to the 800 flat cars, we expect the delivery to commence in February and to be closed in June.

FIG. 5. ARCHED GIRDER FOR SUPPORTING STEEL PIPE LINE AT KLOOF CROSSING, PORT ELIZABETH WATER-WORKS.

SENATOR TALIAFERRO.—How many locomotives were ordered by Mr. Wallace for the Panama R. R.?

MR. STEVENS.—Twenty-four, of which twelve have been delivered, and the balance are on the road.

SENATOR HOPKINS.—Would your plow for unloading flat cars work in the dry season?

MR. STEVENS.—Yes; it will work better in the dry season, but it can be absolutely depended upon when it

is wet too. Now, that is one thing that I have been criticized for, and I will be still more, I presume; but that is a plant that will take care of that material. It is an open question yet among men who handle heavy construction whether the flat car or the dump car is the more economical. But I do know this, that no dump car that I have yet ever seen would handle that material while it was wet.

It was absolutely necessary, therefore, to adopt some such plan as that, unless we were to subject ourselves to nine months a year more delay. I knew that the flat cars could be used. I knew that they could be used economically—probably as much so as any other car. I knew that it was a grave question whether the other cars could be used or not. Therefore I took the chance of getting the flat cars, knowing that they could be relied on.

SENATOR MORGAN.—Mr. Stevens, in regard to the remaining work to be done through Culebra and Emperador, do you rely upon the steam shovel as being the most efficient of the agencies at your command?

MR. STEVENS.—I think it is the best tool that has ever been built up to date to handle that class of material.

You understand that the Culebra cut is what we call a blasting cut. It is rock of different degrees of hardness, from very soft rock through all the medium grades to extremely hard rock, with a certain amount of earth. The earth was very largely on top, and has been removed to a great extent by the old French company; and probably 90% of everything that there is left to move—no matter what type of canal is adopted—is rock, and must be blasted before it can be moved by anything.

SENATOR MORGAN.—So that from your present workings down to sea level you would expect to encounter rock?

MR. STEVENS.—With the exception of certain places where we will find a thin skin, 8 or 10 or 15 or 20 ft. thick in some places, of red clay, and in some places in the stratification of the rock we will find little seams of clay. But it must be drilled, all of it, excepting possibly a pocket here and there. As I say, over 90% of it is rock.

SENATOR MORGAN.—Is the work that is being done there now encumbered or impeded by slides?

MR. STEVENS.—No, sir; not to any great extent.

SENATOR MORGAN.—The former work was—you understand that, of course?

MR. STEVENS.—Yes; I understand it was. No; we are not being bothered by slides.

I only know of two places, and at one of these places that was considered insurmountable I found there had never been any intelligent investigation made. In September I put some engineers up there with some laborers and drills and commenced drilling to find how deep that slide was and to develop the extent of it. I have received since I have been in Washington a report from the engineer to the effect that so far as can be determined—and they have taken everything against them, so as to be sure that it is big enough—the "big slide," so-called, comprises 225,000 cu. yds.

I have told you some of the things that I have found as far as construction is concerned. Now, I had another proposition, which was the most discouraging of all to me, and that was the Panama Railroad. It has a first-class roadbed, well graded, with permanent masonry openings, and thoroughly ballasted, better than the majority of the eastern roads.

SENATOR GORMAN.—What is the maximum grade?

MR. STEVENS.—About 1¼ or 1½%; the curves make it in the neighborhood of 80 ft. to the mile. The ties generally are probably the finest in the world. Some of them have been there forty years and are as sound as the day they were put in. They are made of lignum vitæ.

The rail, at the time the Americans bought it, was, I think, almost entirely very light and badly worn, practically worn out, weighing 56 lbs. to the yard. I took out some this fall that they told me had only been laid four or five years, but it was worn out. It was not heavy rail. The track has all been relaid with 70-lb. rails from one end to the other, and I finished the relaying.

The bridges were old. In fact, the bridge across the Chagres River has the reputation of being the first iron girder bridge built in the world. It was built, I think, 47 years ago. But all the bridges were, for modern traffic, dangerously light, and one of the things I have had to do before we could run any of the new engines which we are now putting in is to strengthen every bridge on the road. I picked up a great deal of old French material in the shape of girders and I-beams, and we are working them over in our railroad shops for strengthening many of the small ones. In the case of others, we have had to drive creosote piling under them and cap them and make them stronger, so that now we have got them so that we can take heavy power over the road.

The sidings were very few, most of them poorly located, and, in fact, there was not very much to the Panama Railroad, either as to railroad or equipment, except the roadbed, which, as I say, was excellent.

But in face of all the discouragement I found, I think, the worst congestion that I ever saw in my life at Colon, where 13,000 to 16,000 tons of freight were piled up in a hopeless mass of confusion. I found freight which they told me had been there for eighteen months. I found that part of the rolling stock of the road was tied up under load by our own men with Commission stuff for Culebra and other points, some of which had been under load ninety days, and still the railroad was unable to move the freight because it had not the equipment.

Everybody was complaining. Nobody could get his freight. I suppose there were 3,000 packages on the docks in Colon and Panama that there were no papers for. I could not tell, nobody could tell, what its destination or its consignees were. Then, I do not like to criticize, but the methods of the people who were operating the road were not, according to my judgment, the best in the world.

SENATOR KITTREDGE.—Was the condition you speak of aggravated by the condition of health on the Isthmus?

MR. STEVENS.—Largely. The chairman asked me, when I commenced this very discursive statement, how I found things on the Isthmus. I found a very bad state of feeling among the employees everywhere. They were scared out of their boots, afraid of yellow fever and afraid of everything.

They were not working with any heart, and I think the most of them would have been very glad if the whole thing had been abandoned. For some time, owing to the change in the chief engineer, they had practically felt that there had been no one there in authority, and that they were rather left alone; and this feeling had gone to a certain extent to the railroad employees. It took a long time, or some time, to disabuse their minds of that notion. But as health conditions got better, and they found that there was somebody there to make decisions and to order them to do something, that soon disappeared, and for the last three months I do not think that in my thirty odd years' of experience I have seen a more faithful, hard-working, loyal set of men than 80 or 90% of the men are to-day.

SENATOR KNOX.—Contented, also?

MR. STEVENS.—Yes, sir; I think they are.

We went to work on this congestion and we gradually dug this freight out. We found out from an examination of a lot of these boxes and packages where they belonged, and we persuaded our southern connections, the two steamship lines running down to South America on the west coast, to take that freight and try and find out who it belonged to.

In the case of some of it we never could find out who it belonged to. We had to pay the claims as they came in, and we have reduced those down until there are very few packages the ownership of which we do not know. In the case of some of them the records are gone, and we are simply selling them by auction, and taking our chances on paying the claims. We are cleaning them up.

SENATOR MORGAN.—What embarrassment has been or is likely to be inflicted upon the operations of the work on the canal in getting in laborers and in sending out laborers, and in getting in materials, etc., by the exposure that we are now under to have quarantine declared against the Isthmus by any powers in the world.

MR. STEVENS.—Oh, it can have an effect, undoubtedly.

SENATOR MORGAN.—Well, it had a serious effect, did it not?

MR. STEVENS.—It had a serious effect on the business of the Panama Railroad; that is all, though. It had no particular effect on the canal business.

SENATOR MORGAN.—On the coming and going of laborers?

MR. STEVENS.—No, sir. You see, as far as yellow fever is concerned, the laborers are supposed to be immune. They are all tropical people, and are in no danger from it. They do not care anything about the yellow fever. That is one thing that makes the sanitary work of Governor Magoon and Colonel Gorgas so hard—because the natives down there, the Panamanians and the blacks, feel perfectly secure. But you whisper "bubonic plague," and there is a different atmosphere in a minute.

SENATOR MORGAN.—How about citizens of the United States who have gone down there?

MR. STEVENS.—Oh, I presume it has had more or less influence; but that fear died away. As far as the yellow fever situation on the Isthmus now is concerned, we have had no case that I recall since the 15th of November; it is merely one of quarantine now. We make a strict quarantine, and keep it in from the outside. I do not look for any trouble with that. I know I went down there in July, in what was supposed to be the height of the yellow fever season, and I had no more fear of it than of going out on the street here.

SENATOR TALIAFERRO.—Is there as much insect life as you had there at first, Mr. Stevens—as many mosquitoes?

MR. STEVENS.—Well, I was there five months, Senator, and if I was bitten by a mosquito I do not know it. I was out at least three days out of the week in the jungles over at Culebra cut and Colon, and running a little boat up and down those old canals and rivers and examining the situation, and I never was bitten by a mosquito to my knowledge.

SENATOR HOPKINS.—I understand you in [illegible] statement earlier to say that one of the great [illegible] was the mosquito question; but that had been de[illegible] successfully before your arrival on the Isthmu[illegible]

MR. STEVENS.—Well, they had undoubted[illegible] them very largely; but, to put it broadly, [illegible] more mosquitoes in a quarter section of N[illegible] than I have ever seen in Panama in five mo[illegible] are no clouds of them like we see on our we[illegible] or away up north at Great Slave Lake or in [illegible] mosquito there which does the most mischief—[illegible] yellow-fever mosquito—is the little black hou[illegible] that breeds in damp, wet places. It breeds in [illegible] bath-room, if you are not careful; in your bath sp[illegible] let it alone a day or two. It breeds in any [illegible] fresh water is allowed to accumulate around [illegible] All this fumigating that is going on is simply [illegible] these mosquitoes, and they have largely decr[illegible] in Panama, Colon, and different other places [illegible] edly so.

SENATOR MORGAN.—Is there any reason [illegible] gentleman who might be the proprietor of this [illegible] railroad down there, the owner of the whole of [illegible] not take out his family and live there and o[illegible]

MR. STEVENS.—Why, I live there.

SENATOR MORGAN.—That answers the qu[illegible]

MR. STEVENS.—And I am in a hurry to get back. I never was better in my life—but then I always have good health. I like it very much there. The climate is not hot from our point of view—that is, the northern point of view—but it is very humid. I have never seen the thermometer over 86, and the nights are always cool. I do not think there have been six nights in the time I have been there that I have not either had a very heavy sheet or a light blanket over me.

SENATOR KNOX.—What is the rainy season?

MR. STEVENS.—It commences in May or June, and lasts through November; but it has not let up yet. I had a letter from my secretary ten days ago, and he said they were having heavy rains there then.

SENATOR HOPKINS.—How many days will pass in the best season on the Zone without any rain?

MR. STEVENS.—There are supposed to be from three to four months with practically no rain whatever. There will be possibly a light shower or two, but not to amount to anything. It gets very dusty, they tell me.

SENATOR KITTREDGE.—Please tell us about the eight-hour requirement and the civil service, Mr. Stevens, and their application to the work.

MR. STEVENS.—We are working under the United States eight-hour law, by decision of the Attorney-General.

SENATOR KITTREDGE.—What is your judgment about that provision of law?

MR. STEVENS.—I think I could do the work cheaper and do it quicker if all restrictions were thrown off as far as the labor is concerned. I would pay less for it, and work them more hours.

SENATOR SIMMONS.—What per cent of those unskilled laborers are Americans?

MR. STEVENS.—About one ten-thousandth of 1 per cent. I do not believe there are ten white laborers on the work.

SENATOR DRYDEN.—Do you depend upon the Jamaica negroes for your labor?

MR. STEVENS.—I have never myself hired any Jamaica negroes. There were a great many who came there previous to my time, and there are quite a number going there now of their own volition.

I got a message yesterday from my assistant engineer, who is working in my place down there now, saying that since Jan. 1 over 500 of them had come back of their own account from Kingston, and they reported that others in large numbers would follow them. We have brought our people, since I have been there, from Martinique and Barbadoes, and from Cartagena in Colombia.

SENATOR DRYDEN.—That fact would indicate, then, to your mind, that on the whole they are satisfied? It would appear so from their return.

MR. STEVENS.—As a body, I know they are. They are earning more money than they ever earned in their lives. I think that the Martinique and Barbados blacks are superior to the Jamaicans, although I am not satisfied at all with either.

SENATOR DRYDEN.—I was going to ask you whether they perform a reasonable amount of work?

MR. STEVENS.—They do not. And, regardless of anybody else's opinion, the greatest problem in building a canal of any type on the Isthmus, or building anywhere in the Isthmus, is the one of labor. The engineering and constructional difficulties melt into insignificance compared with labor. That is the question to-day.

SENATOR DRYDEN.—Have you any opinion which you would care to express to the committee as to the source from which it would be most desirable to get our labor?

MR. STEVENS.—Why, I have no hesitancy in expressing any opinions I may have. I do not know. I recommended some time ago to the Commission that we take measures to bring in Chinese, Canton Chinese. I

have worked Chinese, and I have worked Japanese. I presume I was practically the first man in the United States that ever worked Japanese labor. Mr. Hill brought them in on the Great Northern Railway. I worked Chinese as long ago as 1884, when we were building the main line of the Canadian Pacific road.

I was in the Rockies there for four years on the heavy construction; and I regard the Chinese laborer as a first-class laborer. He will not do as much work as our northern laborer will, of course; we do not pay him as much; but from my experience, if he can stand the climate down there—and he certainly should, in view of the fact that Canton has almos tidentically the climate of Panama—and is properly taken care of, I think that one Chinaman is worth two of the laborers we have now.

SENATOR TALIAFERRO.—Mr. Stevens, how can you get that labor in there under the law?

MR. STEVENS.—I do not know, Senator. That is what I am trying to find out.

SENATOR SIMMONS.—Do not our contract laws apply to the Isthmus as well as our exclusion laws?

MR. STEVENS.—I have never been notified if they do.

SENATOR HOPKINS.—Have you given any thought as to whether it would be advisable to have this canal dug by contract?

MR. STEVENS.—I am thoroughly in favor of contract work.

SENATOR HOPKINS.—You believe it would be to the best interests of the Government to let the construction of it, after the question has been determined as to whether it shall be a lock or a sea-level canal, under contracts?

MR. STEVENS.—I should certainly ask for bids on intelligent specifications; and when I got my bids I could tell what I would do. But I believe in doing the work by contract. There is no doubt about that.

SENATOR SIMMONS.—If it were let out by contract, would not the Government have to manage the transportation facilities over the railroad?

MR. STEVENS.—No; my plan would be to turn all this equipment over to the contractor, and he would run his trains over the Panama Railroad—of course, under the Panama Railroad train dispatchers, which is done in the case of leasing trackage rights anywhere in the world, you know—at a nominal sum, which we would fix, per train mile. Supposing it was 25 cts., and he would run 25 miles; he would pay $6.25 for the privilege of running that train over those 25 miles.

SENATOR MORGAN.—Mr. Stevens, I would like to suggest to you, inasmuch as you have stated that you have a preference for that method of doing work by contract, that before we meet again I would like you to please consider the question as to what changes in the government of the Zone might be made necessary, if we had a lot of contractors working in there. I judge that our first duty would be to protect the contractor and his laborers against outside intervenors and people who might be interfering with their morals, etc., and their business.

MR. STEVENS.—Yes, sir.

SENATOR MORGAN.—And we would have to protect squads of men working under different contractors against each other.

MR. STEVENS.—You have struck the root of the greatest difficulty.

SENATOR MORGAN.—And we would have to protect the contractors against their employees. Now, it occurs to me that in conducting work in that way, the strongest arm of government that the Government can wield at all in the control of the situation there ought to be employed.

My preference would be, and my preference has always been, for treating this Canal Zone under those circumstances as a Government reservation, with the military power of government over all—not to be exercised in a strict military regimen, but with power to control and with a measure and means of controlling every situation that arises, not by going into a court and suing out a writ of habeas corpus or trying a case before a judge, but by ordering the things to be done.

MR. STEVENS.—Of course I have never gone into those questions. But there are two things that the United States Government must retain control of, no matter how the work is done; that is the policing and the sanitation.

SENATOR HOPKINS.—The letting by contract would not interfere with the sanitation of the government of the Zone at all, would it?

MR. STEVENS.—I think not; I think that can be worked out. The point that Senator Morgan brings up in regard to the conflict between laborers belonging to different contractors is another proposition, however, and a very difficult one to deal with. In all large contracts in this country that I have ever been connected with, I have always had inserted in the contract a clause giving the chief engineer, or the railway company, or the corporation a right to fix the hours and the price of labor; and the general control that the chief engineer retains of a railway contract in this country gives him power enough so that he can, nine times out of ten, adjust these labor troubles.

SENATOR KITTREDGE.—Mr. Stevens, returning to the eight-hour feature of this matter, is it possible for American labor to do the manual work on the Isthmus?

MR. STEVENS.—I think it would be possible from a hygienic and climatic standpoint, but not from a practical standpoint, because there is not the American labor to go there, either colored or white.

SENATOR KNOX.—To what extent do you think that ruling that the eight-hour law applies to the Isthmus interferes, with the work?

MR. STEVENS.—As far as the common laborer is concerned, we are paying higher than that class of labor has ever been paid anywhere. We are paying for the lowest classes 20 cts. in silver, 10 cts. in gold; 80 cts. for eight hours. If I had the privilege of working those people ten hours a day, I should not pay them 20 cts. an hour, because it is more than they are being paid anywhere else, and the islands negro is a peculiar being. The majority of them, you know, cannot see very far ahead. As a matter of fact, assuming that it costs those people 30 cts. a day for actual food expenses, and we paid them $1.80 a day for work, I apprehend that one-half of them would work Monday, and they would not work again until next Monday, because that would carry them through.

SENATOR KNOX.—Are those men capable of working much longer than eight hours?

MR. STEVENS.—Oh, yes. They are accustomed to it at the plantations, you know; they work from sun to sun.

SENATOR SIMMONS.—What is the efficiency of the negro that you have down there as a laborer compared with the American negro laborer?

MR. STEVENS.—I should say that the average American negro laborer I have seen and had around me on railways is worth at least two of the island negroes.

SENATOR KITTREDGE.—How about the civil-service restrictions?

MR. STEVENS.—Well, I have had more or less controversy, as you know, with the civil-service people. I suppose my experience there has been rather bitter with the class of men that have gone down. I do not believe that for outside men, for men like trainmen, steam-shovel men, foremen, track foremen, and people of that class we should be held to the civil service examination. As far as clerks, clerical men, inside men, are concerned, I am thoroughly committed to it and believe in it.

SENATOR KITTREDGE.—You think that you should have a free hand in the management and control of outside men?

MR. STEVENS.—I think so.

SENATOR GORMAN.—Well, has not that order been modified, so that you have now?

MR. STEVENS.—I understand that it has, so that all outside men are outside of the civil service.

SENATOR MORGAN.—Has there been any trouble in the Zone among the laborers, etc., arising from drunkenness?

MR. STEVENS.—No; not very much. I will say this for the islands negro: He is the most harmless and law-abiding person for the numbers that we have collected together there that I ever saw in my life.

THE CHAIRMAN.—During the eight days I was there I did not see a drunken man from Colon to Panama, and I was out almost every day.

MR. STEVENS.—No; I am free to say that the worst class we have had down there, to our shame, has been some of our men that have gone down from here. That is another thing that I have been criticized very harshly for. They do not stop very long; I send them home and get rid of them.

THE CHAIRMAN.—The young men there in charge of squads of different kinds along the line seemed to me like very intelligent, bright young fellows.

MR. STEVENS.—They are as fine a body of young fellows as I ever saw in my life. Now there is a club called the University Club in Panama. It has been started recently. They have very elegant club rooms. There are over 300 members of that club; and when you understand that they must be college graduates, either of a college or a university, in good standing, to secure their admittance, you can see what that means. I cannot be admitted to the club, because I am not a college graduate—although I believe they made me an honorary vice-president to get me in. But there is the standard they have set up, and there are 300 in that club.

SENATOR GORMAN.—I would like to have your estimate as to the time that it would require you to put this railroad and all the plans and the paraphernalia in condition to go to work and actually commence digging the canal—economically, I mean?

MR. STEVENS.—You mean after we have provided it with equipment, etc.?

SENATOR GORMAN.—Yes; how long a time will it require?

MR. STEVENS.—We should be able to start within two or three months, the actual work of the excavation, shortly after the arrival of this equipment, and from that on gradually increase our force until possibly a year or a year and a half from now the maximum output could be obtained, and then that ratio or rate of speed, whatever it might prove to be, would continue for several years until the area of the ground will become so small that it will gradually decrease.

SENATOR GORMAN.—You think in six months you will be ready?

MR. STEVENS.—I think we will be ready in a less time than that.

SENATOR GORMAN.—And that will include your buildings for laborers and other employees, the sanitary conditions, and the railroad construction?

MR. STEVENS.—Yes. You understand that a large amount of material is required in the reconstructing of the road, that a great deal of that will come from the canal; in other words, this material instead of going to waste will go to double trackage.

SENATOR GORMAN.—I notice in the report of 1901 that you have stated that thousands of yards of the material from the cut in the divide are loaded and hauled by the French equipment over these tracks, which land and dumps are improperly located and unsuited to the end in view. Now, will you not please tell us something about that?

MR. STEVENS.—From my point of view, neither the track nor the equipment was suitable for handling the work. Recently I gave the opinion that the dumps were improperly located because the hauls were invariably up hill and the dumps were too high, 40 or 50 ft. high, and with that class of material, particularly in the rainy season, these extremely high dumps can not be kept under the tracks, or, to put it the other way, the tracks can not be kept on top. Twelve or fifteen feet is about as high as you can handle a dump economically; your accidents become so prevalent after that that it is not good policy.

SENATOR MORGAN.—In following the line of the canalization of the French Company along the river and across the Chagres River, I will say between Gamboa and Gatun, if the prism of the canal is increased to 150 ft., is it not necessary to remove a great deal of earth that the French have taken out and piled up there?

MR. STEVENS.—I do not think so above Gatun, or not much of it; I have never been the whole length of the canal, but I have never seen any spot where a pronounced amount would have to be removed, at some places some will have to be removed, no doubt.

SENATOR MORGAN.—I want to ask you about the approach from the Caribbean Sea, whether there is any advantage in having a cut made to go out straight through the Bay of Limon, or by way of Colon, which, as I understand it, involves a double curve. What would be your choice between those two propositions, one going straight out through the Bay of Limon, and the other through Colon?

MR. STEVENS.—Well, not being a sailor, I should say that the straight channel would be a decided advantage.

SENATOR MORGAN.—The Walker Commission route contained a double curve in the bay at Colon, and in order to avoid the difficulties of that curve the proposition was to widen the sailing area to 500 ft.; that seems to be a very serious difficulty to be overcome in giving a safe exit or a safe entrance to vessels, particularly in time of high winds or seaway.

MR. STEVENS.—I should say fully 98% of the time, with any curve there, a ship can be navigated in perfectly still water, without any wind, but during the time of northers my opinion is that a vessel coming in straight into the mouth of that canal and then making that curve and turning almost at right angle to the northward, with the wind blowing directly behind her or astern, would have to have a prety wide channel to make the curve.

SENATOR MORGAN.—Taking the reports of the Hydrographic Office, I would suppose that those northers frequently become matters of great difficulty and danger to navigation of ships; it seems that they have to cast their anchors and go out to sea. That has always impressed me as being a very serious objection to the Bay of Colon, through which an approach is made to the canal, and it has been a very serious question with me as to whether we ought not to move the line of the canal to the westward and go straight out to sea through the Bay of Limon, even though it must cost $1,000,000 or $2,000,000 more to do it.

MR. STEVENS.—I agree that a straight channel is better than a curved one at that point. Colon is practically an open roadstead. As far as my reading goes, it seems that the ships pull out from the docks, but it is not on account of the heavy winds that prevail at the time that the boats are lying there, but it is on account of the heavy swell that comes in, and if they remained tied up to the docks those swells would not only smash the docks but probably the ship as well, and so when those northers come up they cast off their lines and go out to sea. I understand they often go way to Portobello to ride out a storm.

SENATOR KITTREDGE.—What would be the effect of the northers upon the canal if the canal was straight out to sea?

MR. STEVENS.—Well, that is a pretty hard question, Senator. You mean in filling up the channel?

SENATOR KITTREDGE.—Yes; and the swells and every element that you have suggested.

MR. STEVENS.—I think that the exposed portions of the canal—that is, when you get out of Limon Bay proper—must be jettied, must be protected by breakwaters. That is my opinion. You have asked me lots of questions about points upon which I have not had the benefit of anybody's studies, nothing except my own observations, and when I am a little doubtful about it I want you gentlemen to understand the reason.

SENATOR GORMAN.—You have made a very frank statement about the conditions on the Isthmus when you took charge and what your predecessor accomplished and left undone. It leaves one branch we have not touched upon, and that is that numerous surveys have been made, not only on the line of the canal, but more particularly for the dam suggested. To what extent do you find that survey was made by your predecessor?

MR. STEVENS.—The work was going along in very good shape.

SENATOR GORMAN.—How much had you to assist you in completing those examinations?

MR. STEVENS.—We worked probably the equal of five or six parties, I suppose, during the entire time, until recently. We are not doing much now.

SENATOR GORMAN.—And is it on the data so obtained that you are now about to determine the type of canal?

MR. STEVENS.—It was, of course, pursued with that end in view, to get that information, and a large quantity of it was turned over to the consulting board.

SENATOR GORMAN.—And a valuable work was accomplished, was it?

MR. STEVENS.—I think so, without doubt.

SENATOR GORMAN.—Do you consider that survey now complete, so that you, as an engineer, are content to rest the construction of the dams, for instance, on the data you have?

MR. STEVENS.—Yes; I feel confident of it.

SENATOR GORMAN.—What I want to get is whether, in your judgment, that survey is as complete as it can be made through the parties under Mr. Wallace, supplemented by your own?

MR. STEVENS.—I think so. There is no doubt but what Mr. Wallace and his engineers were working along right lines, according to my information, and have done a great deal of valuable work.

SENATOR SIMMONS.—You said you had built some hotels and some houses there. Were there not a good many houses already there, built by the French?

MR. STEVENS.—Yes; a large number. Something over 2,000, large and small. They were almost entirely laborers' cottages, located all along the route of the canal from one end to the other.

SENATOR SIMMONS.—What percentage of them will you be able to use by repairing them?

MR. STEVENS.—I should say 80 per cent.

SENATOR SIMMONS.—You think the health and sanitary conditions, and so on, are in reasonably good condition?

MR. STEVENS.—I do; yes, sir. If you will let me explain in regard to that. The greatest menace to health there to-day is the same that obtains along the Gulf and Mississippi River States, and it is from malaria.

SENATOR SIMMONS.—No worse, you think?

MR. STEVENS.—As far as malaria is concerned, I should say no.

SENATOR SIMMONS.—And in regard to yellow fever?

MR. STEVENS.—As far as yellow fever is concerned, no; and especially taking into consideration New Orleans and its yellow fever this past year. To my mind the health conditions on the Isthmus, on which the success of the canal depends, are now largely a matter of quarantine. The Isthmus, of course, is a great thoroughfare; thousands of people go over it from all parts of the world, and so far as yellow fever is concerned, I do not say that there will not be spasmodic cases once in a while. But if we can succeed in keeping it from the outside I do not think we have anything to fear from that.

SENATOR SIMMONS.—After you have finished your projected work of sanitation do you think the health conditions will be reasonably safe for people of the white race?

MR. STEVENS.—I do. I took my wife and child there last fall, and they were healthy while they were there.

SENATOR SIMMONS.—You think there is nothing in the health conditions of the Isthmus to interfere with the success of the canal?

MR. STEVENS.—If properly handled, no sir; I do not.

SENATOR SIMMONS.—And there is no more sickness among the employees than you think would be usual in malarial countries such as the Gulf States and Southeastern Texas?

MR. STEVENS.—I do not think so; no, sir. There is this to be said in reference to the sanitary records. In the Gulf States, the Mississippi Valley, or anywhere else for that matter, even in the North, a person will get a chill and have a fever, and he will keep on walking around and attend to his business. The men down there if they are attacked do not do that; when a man has a chill he is taken to the hospital at once. In that way the number of the cases in the hospital and the number of cases of fever as shown by the records are a great many more than are shown up here.

SENATOR SIMMONS.—I have seen the statement in the press very frequently that an American going there soon finds that the climate takes all the energy out of him. Is there anything in that statement?

MR. STEVENS.—That may be the result of individual experience. I have myself thought no man born and raised in the Northern States can go down there and retain the same liking for work and retain the same amount of ambition that he has up here. The general supposition is that a white man ought to spend a month or six weeks out of the twelve months of the year in a colder country. I do not believe the average white man will go down there and stay four or five years and feel as ambitious as he does up here. I would not expect myself to do so if I remained there long.

SENATOR SIMMONS.—How many unskilled laborers are you working there now?

MR. STEVENS.—I should say in the neighborhood of 10,000.

SENATOR SIMMONS.—How many can you work when you get this preparatory work in readiness to begin the work of excavation?

MR. STEVENS.—We cannot work very many more men than we are working now when we first start; but we will gradually increase as appliances are installed, until, I would say, during the maximum that will be employed, we will be working from 15,000 to 20,000. That is a wide limit.

SENATOR SIMMONS.—With the kind of labor you have got, can you construct that canal within the limits of the estimated original cost?

MR. STEVENS.—That is a pretty hard question, Mr. Simmons. I would not want to be pinned down, because, in the first place, I do not know what sort of a canal we are going to build.

SENATOR SIMMONS.—I am speaking about a lock canal—the original idea.

MR. STEVENS.—I would be inclined to say yes to that question; but that is only an opinion and it may be away off.

SENATOR GORMAN.—You say the great problem there is the labor problem, and you have looked into that question carefully. If the restrictions were removed as to eight hours, and you could work ten hours a day, and the contract feature was abrogated, and you would be permitted to contract for labor anywhere—in China, in Japan, in Spain, or in the United States—then, as I understand it, under those conditions you think it could be solved reasonably well?

MR. STEVENS.—Yes, sir; I do.

SENATOR GORMAN.—If this work were your own what class of men would you look for?

MR. STEVENS.—I should make an experiment with Canton Chinamen. What I mean by experiment is that I would take one or two thousand there and see that they were properly housed and fed as far as I could, although, as you know, Chinamen are obstinate; they want their own way; and I would work them for a few months and see how things resulted. I might say that I am a little disposed in favor not only of the Chinaman as a laborer, but as a man, from my contact with them on the west coast. In fact, I have a very high respect and regard for Chinese of all classes whom I have ever met.

SENATOR DRYDEN.—I think you stated that board costs, for the employees who avail themselves of the privilege, $27.50 a month.

MR. STEVENS.—Yes, sir.

SENATOR KITTREDGE.—What plans have been made and what progress has been made in the completion of the sanitary improvements at Colon?

MR. STEVENS.—We have had plans adopted by the Commission which are now being put into execution, involving the possible expenditure—I think the estimate was something under $300,000—it has been called $300,000 in round numbers, but it is not that much. The sanitation of Colon is a very difficult matter. It is situated on land 1½ ft. to 2 ft. above the surface of the sea; consequently there is no chance for drainage. The plan we have adopted is, first to dig a channel through one of the very wide streets clear through the town from one side to the other, I think 10 ft. wide and 4 ft. deep, connecting it with the salt water on both sides, so that the rise and fall of the tide twice in twenty-four hours will sweep through there. I do not think that is an experiment, because we have some small ditches of that kind there already; the railroad company built them several years ago.

Now it is proposed to do a certain amount of filling on those streets; to first establish streets and then pave the streets, that is, give them a coating of rock, which can be obtained very near Cristobal, and then a coating of gravel over the top for the working surface, and then to concrete the gutters and carry the surface water through a tidal channel through the town, with the expectation—which I think will be realized—that it will clean out this water at least twice a d... Then, in addition to that, to put in a sewerage ... m from house to house, and drain this house sew... to what we call a sump or sewer well and pump t... it to the sea. That, in general, is the plan adopted.

SENATOR MORGAN.—Are there mater... there to make hydraulic cement?

MR. STEVENS.—I do not know that, and ... arranging for a geologist to accompany me b... there, if possible, to make an examination not o... r that, but also to ascertain what there is in ... hape of building stone.

SENATOR MORGAN.—What are the cu... prices you pay for cement at the Isthmus?

MR. STEVENS.—I think they are paying ... at $1.95 a barrel now.

SENATOR GORMAN.—There has been a g... deal of comment about the compensation of ge... en employed on the Isthmus. What is the high... you pay for men under you in the engineering corps?

MR. STEVENS.—$15,000.

SENATOR GORMAN.—What is the gentlem... name?

MR. STEVENS.—Mr. Sullivan.

SENATOR GORMAN.—How does that compa... with the compensation that that gentleman would receive here on any one of the great trunk-line railroads?

MR. STEVENS.—I do not know that any l... have a man corresponding with that. The trunk lines here pay for a Chief Engineer anywhere from $7,000 to $20,000.

SENATOR GORMAN.—What work was Mr. Sullivan on before he went out there?

MR. STEVENS.—He was on the Canadian Pacific. He is a graduate of Cornell, a New York man.

SENATOR GORMAN.—And his compensation was what?

MR. STEVENS.—I do not know what he was getting; he was a man who had been with me a number of years ago on the Great Northern.

SENATOR GORMAN.—Do you regard his salary as excessive?

MR. STEVENS.—Not for the work I expect him to do; I expect him to take my place fully in case I should break down.

SENATOR GORMAN.—A very high type of man?

MR. STEVENS.—I regard him so; yes.

SENATOR GORMAN.—What is the average compensation of your principal engineers on the work?

MR. STEVENS.—$6,000 and $7,500, as I recollect it.

SENATOR GORMAN.—And they could not be had for less?

MR. STEVENS.—I do not say that engineers could not be hired for less.

SENATOR GORMAN.—I mean the type of engineers that you want in this work.

MR. STEVENS.—To my personal knowledge I do not think I could get the type I want for less than that.

SENATOR GORMAN.—Have you any idea of how much you are paying to your subordinate engineers?

MR. STEVENS.—No, sir.

SENATOR GORMAN.—Do you know how many you have?

MR. STEVENS.—I could not tell you that. There is this to be said about the engineering corps. To a certain extent I feel that my hands are tied as to what I should do. For instance, I know that certain members of the consulting board would recommend changes in the course of the canal and for large portions of it, and if changes were made it would have to be gone over again, which would mean that unless I had a large force of engineers on the ground there would be long delays before we could even stake the canal out or make specifications or place it before the public for bidding, or even know what to do, and for that reason I have retained quite a large force there until the canal route is definitely decided. I know I could not get that corps of men together very quickly if I let them go away from the Isthmus.

SENATOR GORMAN.—You could reduce your force if the type of canal had been fixed?

MR. STEVENS.—Yes; quicker than I have been able to do it under the present circumstances.

SENATOR GORMAN.—There is a material that is described by the engineers of the Isthmian Canal Commission on their examination before this committee at a previous time—a material called indurated clay, or hard pan—which they found at the bottom of wells sunk by the French, and tunnels that had been run by them as test pits to ascertain the character of the material there.

Colonel Ernst testified that he carried some of that hard pan to the surface and immersed it in water and it dissolved, from which he concluded that it was not clay; that it was some other material that had been compacted by pressure. He also mentioned the fact that in that same locality he has found the teeth of sharks in the wells, a strange circumstance, it seemed to me, and presenting a difficulty as to the friability and solubility of the material at sea level that might prove serious in the case of that finding on the bottom of the wall of the canal. Have you ever made any examination of those features?

MR. STEVENS.—I have not tested it by trying to dissolve it in water. I have never seen any of that indurated clay south of the cut or south of San Pablo, as I recollect it; but as a matter of fact the French dug a dry dock at Cristobal in this material right off the line of the canal, which is there to-day, and which we have in use and which I am preparing to enlarge.

They simply dug this dock right out of that as they would out of the solid rock, and it has been full of water ever since, probably for twenty years, and the walls to-day are as firm and true as the walls to this room. Up and down the Chagres River are several points where this indurated clay, so-called, projects above the surface, and repeatedly in going up and down in canoes and other boats I have examined these almost vertical faces in the comparatively soft ground and have been unable to see that there has been any indication of the action of the water on them.

SENATOR MORGAN.—So you have no apprehension of that material in the bottom of the canal?

MR. STEVENS.—I have not the slightest. I think it would be an ideal material for it. Near this dry dock I am taking down a little hill now, moving the material with the steam shovel to build a switching yard for the railroad at Cristobal. We have to drill and shoot every bit of it before we can handle it with the steam shovel.

THE CHAIRMAN.—When you get your Panama Canal started, which will be from Cristobal, what use will you have for your railroad down to the east and for the town of Colon?

MR. STEVENS.—I can see very little.

THE CHAIRMAN.—It seems to me that money spent in Colon at present would be simply for sanitary purposes.

MR. STEVENS.—Entirely, but I think the justification is that for a number of years Colon will be the northern terminus of the canal and people will have to live there, and so that would justify the expense of improving the conditions in the city.

MR. TALIAFERRO.—Speaking of the economy, or want of economy, in the expenditures down there, did not I understand you to say that you had been using some of the French dumps where the material would have to be moved later, and that has been done since we have been doing the work?

MR. STEVENS.—No; you did not understand me correctly. Whatever material we have to move or will have to move was material that was dumped there by the French.

MR. TALIAFERRO.—Did you not say you were using some of the same dumps?

MR. STEVENS.—Some of the same dumping grounds, but putting it farther in. There has not been a spoonful that we have dumped that will have to be dumped again: no.

SENATOR GORMAN.—I am glad to have you make that statement. There was a public statement that some of the stuff Mr. Wallace had taken out had to be removed.

MR. STEVENS.—No; that is a slur on Mr. Wallace; that is not so at all.

NEW LOCOMOTIVE AND CAR SHOPS OF THE LOUISVILLE & NASHVILLE RY.

Within the past few years there has been a general movement towards the enlargement and improvement of railway locomotive and car shops. The Louisville & Nashville Ry. has recently completed at South Louisville, Ky., an entirely new plant for the building and repair of locomotives and cars. The plant is intended to have an ultimate capacity, when fully equipped, for building 25 locomotives, 25 passenger cars, and 3,600 freight cars annually, while the heavy repairs will cover about 450 locomotives and 15,000 passenger and freight cars annually. In addition to this there will, of course, be a considerable amount of light repair work to both locomotives and cars. The plant was designed under the supervision of Mr. T. H. Curtis, Superintendent of Machinery, and the buildings were designed under the direction of Mr. Richard Montfort, M. Am. Soc. C. E., Consulting Engineer, and Mr. W. H. Courtenay, M. Am. Soc. C. E., Chief Engineer. Mr. J. Werness, Principal Assistant Engineer, had charge of the work.

The plant occupies a site of about 55 acres, with a maximum length of 4,000 ft. (north and south), and a width of about 1,100 ft. at the middle. The buildings cover about 12 acres, and are all accessible from a road or driveway 20 ft. wide, for wagons and also for fire apparatus in case of emergency. The general arrangement is shown on the plan, Fig. 1. Across the middle of the site is a transfer table pit nearly 920 ft. long and 75 ft. wide, serving both the locomotive and the car departments, and separating these departments, except that the freight car repair shop and yard lie along the east side of the plant beyond the limit of the transfer table.

On the north side of the transfer table is a building 813 ft. long and 170 ft. wide, comprising the locomotive erecting, machine and boiler shops. Beyond this is the blacksmith shop, and a space reserved for a future boiler shop and a roundhouse with 44 stalls. North of the blacksmith shop is a building for wheel work and freight car material, and beyond this again is the foundry building. At each end of the foundry is a flask yard, and behind it are the pig-iron stock yard, coke shed, and a building for the pattern shop and pattern storage. The foundry, car material shop, blacksmith shop and machine shop all front on a material or stock yard, 1,000 ft. long, at right angles to the transfer-table pit; this yard is served by a 10-ton overhead electric traveling crane of 40 ft. span, with a clear headway of 15 ft., and a speed of 1,000 ft. per minute. This can handle all material between these shops and the transfer table. Raw material is delivered by cars entering at the north side, and is handled from shop to shop or distributed in the yard by the yard crane; the product of the shops works its way south, the finished locomotives being delivered to the transfer table.

On the south side of the transfer table are four main buildings: the coach and paint shop, freight car shop (for building new cars), planing mill, and general store house. South of this row of buildings are the power house, lumber shed and yards, dry kiln, etc.; the yard tracks are spaced 60 ft. c. to c. The lumber enters at the south end, and makes its way north. It is handled on cars with floor 2 ft. above the rail, and platforms of the same height are used to facilitate loading and

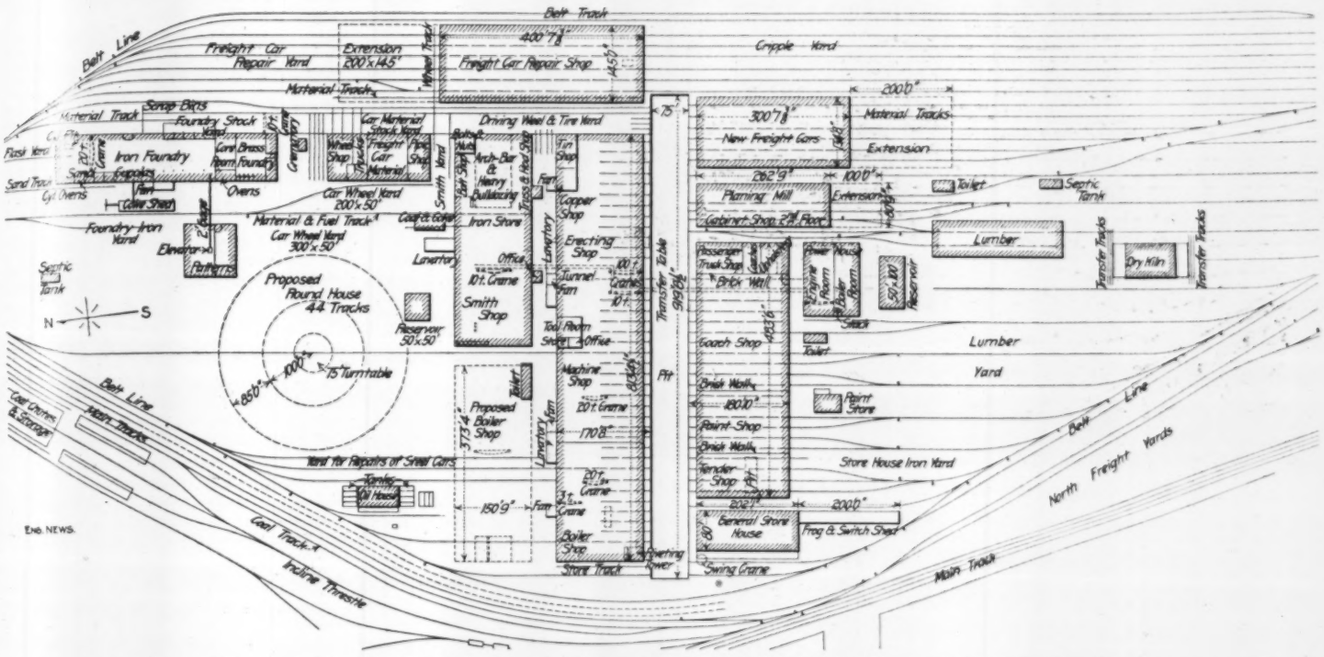


FIG. 1. PLAN OF NEW LOCOMOTIVE AND CAR SHOPS AT SOUTH LOUISVILLE, KY.; LOUISVILLE & NASHVILLE RY.

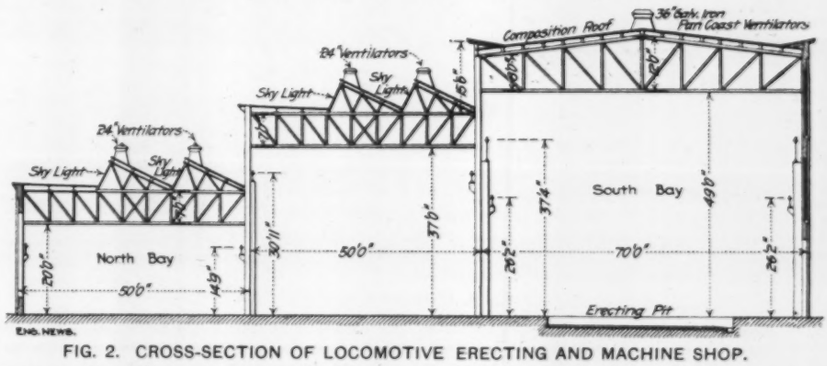


FIG. 2. CROSS-SECTION OF LOCOMOTIVE ERECTING AND MACHINE SHOP.

unloading. The freight car repair facilities form an independent group along the east side of the plant, served by longitudinal tracks. At the south and opening from the belt line is the yard for crippled or damaged cars (325 cars capacity); next to this is the freight car repair shop (60 cars), with space for lengthening it 200 ft. to increase the capacity to 90 cars; north of this is the freight car repair yard (50 cars), with tracks

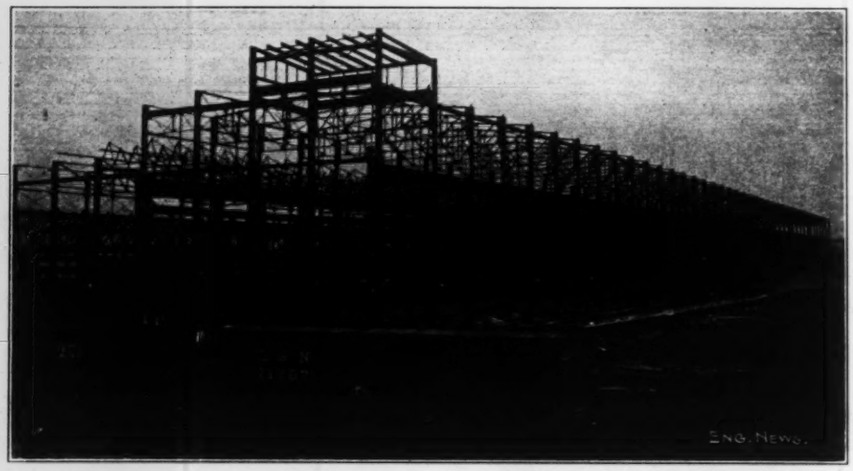


FIG. 3. STEEL FRAME OF LOCOMOTIVE SHOP (WITH RIVETING TOWER).

connecting with the belt line track. The shop is served by the stock-yard crane already mentioned. Each end of the plant has its own system of yards and individual tracks, and no narrow gage shop tracks are used except to serve the foundry cupolas and the pattern shop, and to deliver coal and coke to the blacksmith shop.

The buildings have concrete foundation walls and piers supported on creosoted piling driven through sand and quicksand to gravel. The large buildings are of steel frame construction, with red brick walls, except that the freight car repair shop has corrugated iron sheathing. Some of the smaller buildings have brick walls and interior steel framing. The saw tooth type of roof is used for the foundry, the coach shop, and part of the main locomotive shop. The roofs are of concrete, hook tile, or plank sheathing, covered in all cases with a composition roofing material. Large circular ventilators are placed along the ridges of the roofs. Terra cotta and stone are used for the copings, sills, etc., and all the gutters and rain-water spouts are of copper. The steel work of the roof trusses and interior columns is painted gray.

LOCOMOTIVE SHOP.—This immense building, 813 ft. long and 170 ft. wide, contains the boiler, erecting and machine shops; but, as already noted, provision is made for a future boiler shop 151 x 375 ft. with a 25-ton crane and riveting tower with 20-ton crane. Along the back of the building are four annexes, containing four fan rooms, two wash rooms and a lye vat room, while an interior structure in each department contains a tool room and store room, with foreman's office above the latter. At the west end is a hydraulic gap riveter with riveting tower 34 x 25 ft., in which boilers can be suspended by a 20-ton crane for riveting. At the other end are the tin shop, copper shop, and air brake room. The pipe tunnel from the power house enters this building, and connects with a pipe trench extending throughout its length and covered with cast-iron plates. The floor is of concrete. The cross section, Fig. 2, shows the general design.

The building is arranged on the "transverse track" plan, and has 29 tracks in the erecting shop (20 ft. c. to c.), and ten tracks in the boiler shop; three tracks pass through the building. The locomotives are handled by a single 100-ton traveling crane of 70-ft. span. The 70-ft. span on the south side, fronting upon the transfer table pit, has a high roof, 49 ft. clear above the floor, and its columns carry two sets of crane runways for a 100-ton and two 10-ton traveling cranes. The middle and north 50-ft. spans are lower, and these trusses carry two lines of saw-tooth roof, with 24-in. and 36-in. Pancoast ventilators, 20 ft. apart along the ridges. The trusses are all 20 ft. apart, which is the spacing adopted in all the buildings. The middle span has two 20-ton traveling cranes and the north span has a 3-ton traveling crane at the west end. Fig. 3 shows the steel framework erected.

COACH, PAINT AND TENDER SHOP.—This building is 482 x 180 ft. Across the east end are the passenger truck shop, coach store room, and upholstering room; above the two latter are a finishing room and lavatory. The coach shop, 220 ft. long, has eleven tracks, five of which extend through the shop. Next to this is the paint shop, 120 ft. long, with four through tracks and two stub tracks. At the west end of the building is the tender shop. Three fire walls (extending above the roof) separate the four divisions of this building, and have openings fitted with automatic sliding fire doors. The floors are of concrete. The wall and central columns carry parallel-chord trusses, 20 ft. apart, on which are the saw-tooth frames, as shown in Fig. 4. The coach and paint shops have capacity for 22 and 12 coaches respectively, and the tender shop has capacity for 15 tenders and trucks.

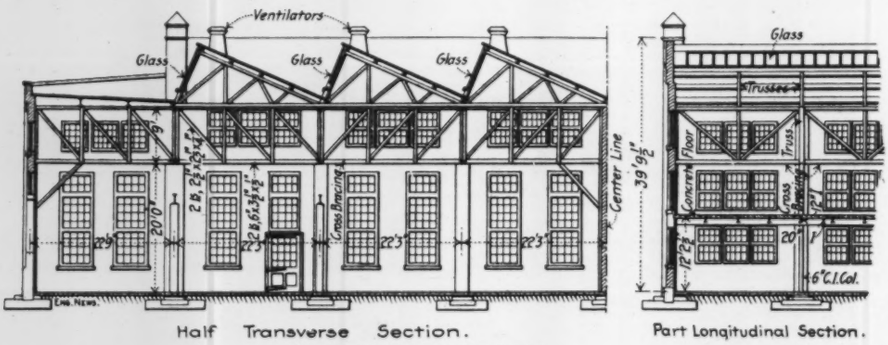


FIG. 4. COACH SHOP.

FOUNDRY.—This building is 442 x 7[illegible], and contains the iron foundry (320 ft. l[illegible], core room, brass foundry, with finishing [illegible]m and brass store room. At the north end of th[illegible]oundry is a cylinder casting pit, 10 x 20 ft., pa[illegible]d with brick. Along one side is a platform, 4 [illegible] 3 ins. above the ground and 102 ft. long, exte[illegible]ing 10 ft. inside and 20 ft. outside the building; on this are located the rattlers. This and the [illegible]rging platform are built of I-beams and brick [illegible]rches, covered with concrete, and paved with [illegible]trified brick on edge, like the cylinder pit. On t[illegible] other side are the cylinder ovens, and bins f[illegible] sand, clay, brick, etc.; also the cupola house an[illegible] charging platform, 80 x 20 ft. Outside of the [illegible]ilding is an annex 20 x 62 ft., with a fan room and a wash room. A 2-ft. gage track from the [illegible]attern shop enters the south end of the foundry. There are two 40-ton cupolas, and one 2-ton [illegible]upola, served by a turntable elevator and lines of 2-ft. gage extending to the pig-iron and coke yard.

BLACKSMITH SHOP.—This is of steel frame construction, with two rows of interior columns. A material track runs across the building, separating the smith shop (250 ft. long) from the arch-bar and heavy bulldozing shop; in this latter also are the truss-rod and brake-rod shop, bolt shop, and bolt and nut room. Adjoining the building are two fan rooms on one side, and a two-story lavatory on the other side. Along the ridge of the central roof are 3-ft. galvanized iron ventilators, 40 ft. apart. The sides of the monitor and side roofs are composed entirely of windows, all mounted on pivots except where the diagonal bracing interferes. There are large windows in all the panels of the brick walls. The main entrance has wooden sliding doors, and Kinnear steel rolling doors are used for the doorway of the material track.

CAR MATERIAL AND WHEEL SHOP.—This building contains several departments auxiliary to the freight car repair shop. Besides the storage of car material it has the wheel shop, truck and spring shop, pipe shop, etc. At the west side is the car wheel yard, and parallel with the north end of the building are tracks for mounted wheels and axles. The columns of the east wall of the building have outside brackets carrying one of the runway girders for the yard crane. (Fig. 5.)

FREIGHT CAR REPAIR SHOP.—In order to secure ample light, the sides of this building are left open for a height of 10 ft., above which there is corrugated sheathing and large window area, with stationary sash. As shown by the sections Figs. 6 and 7, the building is low, and has its floor obstructed only by one middle row of columns, which (with the side columns) support roof trusses of 145-ft. span, spaced 20 ft. c. to c. A very large monitor roof 55 ft. wide, with top skylight and side windows, extends the whole length of the building, and the side windows have pivoted sashes. Along the lower part of the roof on each side of this monitor are raised skylights in each alternate panel, and along the ridge of the roof are 12-in. ventilators, 40 ft. apart. The floor is of concrete, and there are six repair tracks, 20 ft. c. to c., with a capacity of 60 cars; while along one side runs a material track.

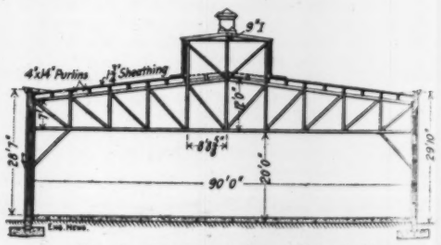


Fig. 5. Car Material and Wheel Shop.

FREIGHT CAR SHOP.—The shop for building new freight cars is 300 ft. long and 135 ft. wide, with provision for an extension of 200 ft.

PLANING MILL.—This is a two-story building, with the cabinet shop on the upper floor. A special feature of this building is that the second floor is supported by wall connections and by suspension rods from the roof trusses, there being no columns on the first floor. A line of 20-in. I-beams is built into the inner face of each side wall, and two

pairs of 8-in. I-beams are supported by 3½-in. rods, with the lower end upset to 4¼ ins. for the nuts, and the upper end having an eye for the pin connection to the truss. These divide the width of the building into three panels, in which are transverse lines of 18-in. I-beams, 5 ft. c. to c., framed between the beams. This steel framing carries a concrete floor with granitoid wearing surface, designed for a load of 250 lbs. per sq. ft.

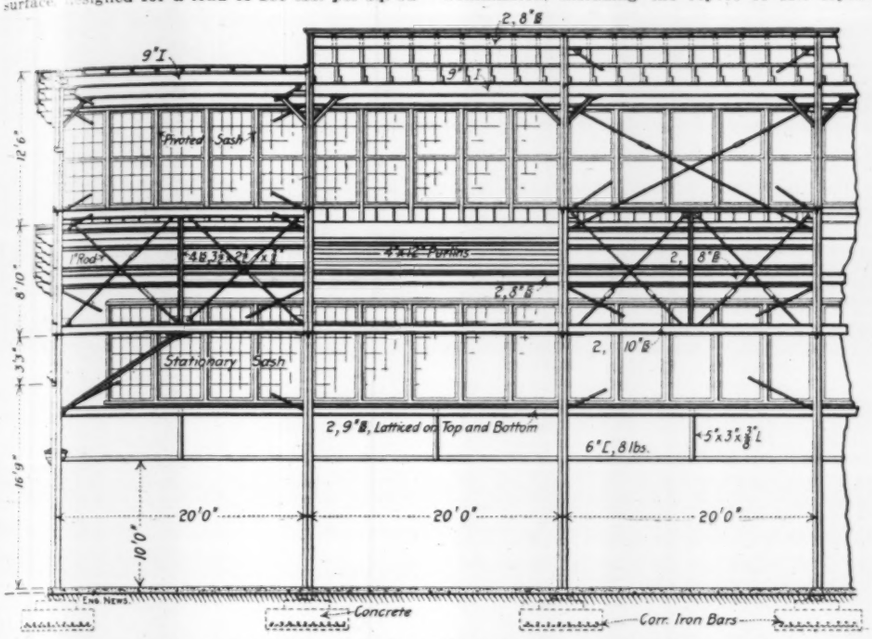


FIG. 6. CROSS-SECTION OF FREIGHT CAR REPAIR SHOP.

The main floor is also of 6-in. concrete, with granitoid top.

POWER HOUSE.—The power house is divided into an engine room and a boiler room; each of these has a monitor roof with pivoted sashes. The boiler room has a steel coal bunker of 500 tons capacity over the firing floor, and at one end of this is the ash bin, with inclined chute extending through the wall to discharge into cars standing outside. This bin is lined with reinforced concrete. The coal is delivered into a hopper beneath the track, and, after passing through a crusher, it is elevated and delivered to the overhead bunker by a continuous conveyor. There are eight 305-HP. Stirling water-tube boilers, with chain grates, and chutes leading from the ashpits to discharge into the conveyor. Some of these are fitted for burning shavings. There are three cross-compound engines, with cylinders 18¾ x 21 ins. and 32½ x 21 ins., driving three electric generators. The two air compressors have each a capacity of 1400 cu. ft. of air per minute, supplying air at 100 lbs. pressure in the pipe system. A pipe tunnel, 7 x 8 ft., extends to the locomotive shop, a distance of 650 ft.

WATER SUPPLY, SEWERAGE, HEATING AND VENTILATING.—Water is obtained from the city water supply, and piped throughout the plant for general and fire protection purposes, and there are two reservoirs for rain water from the roofs. Two distinct systems of sewers (separated by the transfer table pit) serve the north and south sections of the plant, and each ends in a septic tank, the overflow from which is discharged into a surface drainage ditch. Most of the buildings are heated and ventilated by the blower system.

CONTRACTORS.—The principal contractors were as follows: Structural steel: American Bridge Co., Louisville Bridge & Iron Co., and Grainger & Co. Foundations: Cook & Laurie Contracting Co., of Montgomery, Ala. Concrete: National Concrete Construction Co., of Louisville, Ky. Brick, carpenter and mill work: John P. Agnew, of Chicago; and Rounnel Bros., J. N. Struck & Bro., and the L. Just Co., of Louisville. Roofing: the Southern Roofing & Paving Co., of Louisville. Sheet metal and skylight work: J. F. Wagner & Sons and Wulff & Co., of Louisville.

REPORT OF THE NEW YORK STATE WATER SUPPLY COMMISSION.

Some interesting facts and recommendations on public water supplies and on sewage disposal in New York State were submitted to the Legislature on Feb. 1 in the form of the First Annual Report of the New York State Water Supply Commission, including the report of Mr. Myron S. Falk, of New York City, Consulting Engineer to the Commission.

The Commission was organized in June, 1903. It was created, according to its report, for the purpose of seeing that proper direct and indirect damages were made to persons affected by the taking of land and water for public water supply purposes, and also to protect the rights of one municipality against the doings of another. In addition, it was also the duty of the commission to report, this winter, on all the public waterworks and sewage disposal systems of the State, and to make recommendations for State systems of both water supply and sewerage. Under the law creating the commission, all plans for new water supplies must be submitted to it for approval.

In its report the commission states that water and sewage disposal systems for the entire state are impracticable. A State water survey is recommended. The report of the engineer includes statistics for nearly all public water supplies of the State and also a recommendation of a novel plan for the protection of public water supplies.

In opening its report the commission calls attention to the fact that prior to the date of its creation any municipal civil division of the State could condemn lands for municipal water supplies without regard to the justice or injustice of the plans to other municipalities. It was a case of first come, first served, and was subject to all the more abuse because land and water could be taken under the power of eminent domain.

Some of the ideas of the commission on this subject may best be expressed by quoting its report as follows:

> The necessities of the people in thickly populated sections entitle them to the right to reach out, and, under proper and reasonable supervision, with due regard to the wants of the locality for like necessities and subject to the payment of equitable damages, to divert these waters for their own municipal and domestic uses.
>
> Other important problems to consider in this connection are whether the plans of a municipal corporation are justified by its necessities; and whether the common law rule of damages so long established in this State makes provision for just and equitable compensation for the taking of private property by a municipal corporation for a water supply outside its own limits.
>
> It is claimed that in a great many instances, and especially in the construction of a large public work for a latent public purpose, like a reservoir, as distinguished from an active one like a railroad, a hardship is inflicted and an injustice done individuals and communities in which the work is performed, for which no recognized rule of compensation has heretofore been laid down.
>
> A realization of these conditions induced the Legislature and the Governor to enact the law creating this commission. By this act, the people of New York departed from the customary rules and determined that when a municipal corporation or other civil division of the State exercised the right to take or acquire new or additional sources of water supply, all damages to persons or property, direct or indirect, which would result from the acquisition of lands or the execution of the plans, should be justly compensated.

Between June 28, 1905, and Feb. 1, 1906, the commission held 34 meetings, including public hearings on applications for approval of plans for new water supplies for New York City, Oneida, Lyons Falls and Constableville. The attention of the commission has been chiefly directed to the New York plan for a supply from the Catskills at an estimated cost of $161,000,000. This work, in the language of the commission, would involve

> the construction of tunnels, aqueducts and a reservoir of unequalled magnitude in the Catskills, the submerging of settlements, the obliteration of water powers and the relocation of a railroad, demanding most careful scrutiny and deliberate consideration. No other water supply problem of equal importance has ever been prepared in this country.

During the hearing, the report states, the attention of the commission was called to the fact that the proposed supply would be sufficient for only 20 or 25 years from the present date. The commission deems it probable that eventually the Hudson River must be utilized, most economically perhaps at a point above Poughkeepsie.

To throw light upon the questions of water supply and sewage disposal, the commission undertook to collect complete information on this subject for all the municipalities of the State. It found as

> it believes that many municipalities have now for the first time begun the work of systematic collection and preparation of statistics relating to their water supplies and sewage disposal.

The statistics thus far collected are in many cases so incomplete that they will have to be supplemented by further inquiries and probably by personal visits on the part of agents of the commission.

Although it would be supposed that local health officers would have sanitary control over public water supplies, the report says this is rarely the case, this power being lodged with local departments of public works or water commissions or private corporations. Moreover, with the exception of a few larger cities and infrequent examinations in behalf of private companies, "New York State is deplorably deficient in the public supervision of its water supplies." The commission deems it unfortunate that New York State has not followed the example of Massa-

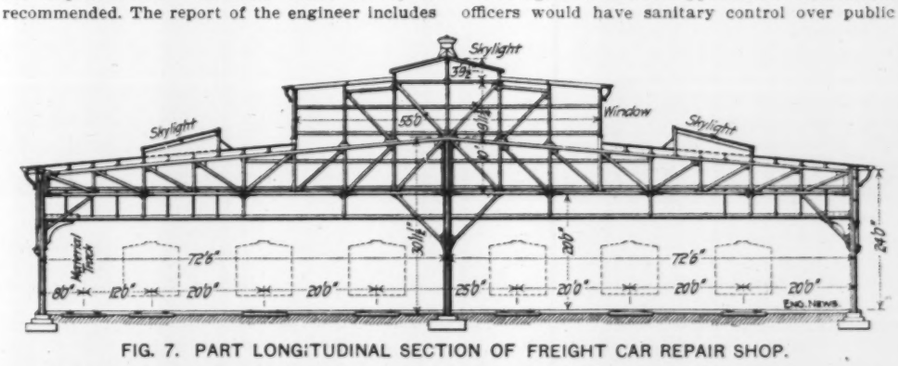


FIG. 7. PART LONGITUDINAL SECTION OF FREIGHT CAR REPAIR SHOP.

chusetts in the control of its public water supplies. During the last five years the New York State Board of Health examined 1,402 samples of water and sewage, counting chemical and bacterial tests separately, while for the same period the Massachusetts Board made over 30,000 analyses, *not* counting chemical and bacterial tests separately. Since 1895 the Illinois State Water Survey has analyzed 13,873 samples of water.

In the matter of sewage disposal, the commission urges most careful attention to "the final disposition of all household wastes, wet or dry, of country as well as city homes." It holds that the final disposal of sewage is incumbent upon the community where it originates.

The report of Mr. Myron S. Falk, Consulting Engineer to the Commission, opens with the statement that of requests for information on public water supplies sent to all incorporated municipalities in the State, replies were received from 39 of the 45 cities and from 262 of the 438 villages.

For the villages not responding to the inquiries, information was compiled, so far as available, from the "Manual of American Water-Works" for 1897, thus reducing to 91 the number of villages from which no information was received. It was assumed that these villages have no public water supply.

Municipal ownership prevails in all the 45 cities of the State and in 275 of the 438 incorporated villages. In addition, a number of unincorporated villages are supplied, as stated in a foot-note to the accompanying table. The table just mentioned summarizes the incorporated places having water-works, both by sizes and ownership.

Classification by Size and Ownership of Incorporated Places in New York State Having Public Water Supplies.

Population, State Census, 1905.	Total.	Having Public Water Supply Under Municipal Ownership.		Without Public Water Supply.	
		Number.	Population.	Number.	Population.
Under 500	16	11	6,061	52	18,999
500— 999	55	33	40,357	73	49,953
1,000— 1,499	52	33	62,504	23	27,828
1,500— 1,999	35	21	59,893	12	21,169
2,000— 2,499	26	12	57,536	3	6,526
2,500— 2,999	21	12	56,943	...	.....
3,000— 3,499	10	5	32,114	...	.....
3,500— 3,999	14	10	52,393	...	.....
4,000— 4,499	12	8	50,053	...	.....
4,500— 4,999	6	2	28,359	...	.....
5,000—10,000	26	12	169,948	...	.....
10,000—50,000	38	27	691,507	...	.....
Above 50,000	9	8	5,047,858	...	.....
Totals	320	194	6,355,526	163	124,475

This table has been prepared so that it may be compared with the one furnished annually by the Massachusetts State Board of Health. For example, page 209, Report for year 1903.

In addition to the data shown, 97 private water companies supplying villages not yet incorporated, and three unincorporated villages responded, stating that they provided public water supplies; the information concerning these smaller constructions will be found separate from the incorporated municipalities in appendix. (Not yet available.—Ed.)

A municipality, served by both a private and a municipal corporation, has been placed in the column of municipal ownership.

Total population of State, 8,066,672.

There is a paucity of information throughout the State on the consumption of water. The relatively few records kept up are based on house meters or pump counters. Mr. Falk adds:

> The installation of meters on the delivery mains cannot be too strongly recommended to any water-works corporation, whether private or municipal.

A large and perhaps the most important part of Mr. Falks report deals with the subject of a

STATE SYSTEM OF WATER SUPPLY.

The commission was directed (Sec. 6, Chap. 723, N. Y. Laws, 1905) to report on "the advisability of, the time required for and the expenses incident to the construction of a State system of water supply." In passing upon the feasibility of such a scheme the plan pursued by Mr. Falk was to analyze the distribution of population in the State, using for that purpose the State Census of June, 1905. Excluding the counties comprising New York City, "the water supply of which requires separate treatment," Mr. Falk finds that the greatest density of population is 450 in Westchester Co. (adjoining New York City); Monroe, Albany and Schenectady Counties follow, with densities of 350, 334 and 324, respectively. Going to the other extreme, the density in Essex Co. is 17 persons per square mile; Lewis, 21; Franklin, 29; Delaware, 30.

Mr. Falk states that sections with a population density of only 50 per square mile "can always be supplied with water from its [their] immediate neighborhood," and that the combined area of three large sections of the State having such an average population is 29,030 square miles, or about 59% the total area of the State. He believes that "it can confidently be expected that the yield of water from these [three] districts may be used for the wants of neighboring counties." An extensive area in addition to the three districts named has an average population of not over 78 per square mile, and may be termed self-contained in the matter of water supply. The portion of the State lying outside the four districts just named includes 22 counties, 11,886 square miles in area, or about 24% of the total area of the State, and containing a total population of 6,364,786, or 79% of the population of the State. Regarding these 22 counties, Mr. Falk says, "it appears probable that recourse might of necessity be had to territory outside of itself for supply of water." The counties involved are the five comprising New York City; Westchester, Rockland, Orange, Dutchess, Rensselaer, Albany, Schenectady and Montgomery, in the east; Niagara, Erie, Chautauqua and Monroe, in the west; and Oneida, Onondaga, Cayuga, Chemung and Broome, in the center of the State. As a rule, it is made evident by the report, that even in these sections of the State, which must go outside their own municipal limits for the water supply, the larger places are so well distributed that they will find no difficulty in securing public water supplies without conflicting with the needs of other municipalities; particularly, we may add, if competent State supervision is exercised. Consequently, the problem, as Mr. Falk states, is one of "furnishing supplies to separate municipalities, or perhaps to some densely populated districts, but not to the State as a whole."

Mr. Falk submits a plan "of State supervision and control of the water supplies of the State," which "may incidentally aid in the solution of the sewage disposal question," water supply and sewage disposal being in this case inseparable. This plan, in somewhat condensed form, we reprint, as follows:

> The plan is nothing more or less than an adaptation of the system of certified milk inspection to water; that is, the commission would issue a certificate to any village, private water company or isolated water plant such as a summer hotel, in which certificate there would be set forth that on a certain day an inspection of the water plant had been made and analyses of the water made by experts of the State Water Supply Commission; that certain suggestions had been made on that day; that these suggestions had been faithfully carried out as a re-inspection on a subsequent date showed; and that on the date of certification the water was of a certain standard.
>
> This plan would remove the drastic power of condemnation of water supply, of which so many communities are afraid, and it would operate more as a plan of persuasion, since it is believed that few localities would remain without the certification of the State Water Supply Commission. The commission would examine at first only such supplies as it would be requested to examine and it would offer at that time certain recommendations. If these recommendations be carefully followed, the commission would then issue its certificate; in other words, the control of the purity of the water supplies would be dependent upon the cooperation of all municipalities in the State.
>
> If this plan be successful, the sewage disposal problem could perhaps be controlled in the same persuasive way, and without bringing that matter into any greater prominence; for if the State Commission should suggest as necessary, certain changes for the proper disposal of sewage and refuse in order that it may issue a certificate of the purity of a water supply, some steps would probably be taken to remove such nuisances and no harsh measures would have been necessitated.
>
> This plan cannot be expected to include the large cities of the State; these cities are able to protect their own water supplies, without the aid of trained men.

The plan would involve the employment of trained assistant engineers, of which there are none, and a small laboratory, all at an estimated cost of $10,000 a year.

Other recommendations made by Mr. Falk are for the establishment of rain gages throughout the State, the purchase by the State of the "highlands surrounding the headwaters of the streams of the State," and the "repeal of all legislation prohibiting one civil division of the State from obtaining water rights in another" section. The necessity of such prohibitory legislation no longer exists, Mr. Falk says, now that all plans for water supply are passed upon by the commission.

POWER PLANT ECONOMICS.*

By Henry G. Stott,† M. Am. Inst. E.

Three years ago the steam-power plant for generation of electricity had apparently settled to an almost uniform arrangement of standard apparatus in which one power plant differed from another in details of construction of engines, generators and auxiliaries. As only about 20 years had then elapsed since the first central station was put in operation on a commercial basis, this uniformity of design seemed to indicate that in the near future it would only be necessary to purchase a standard set of power-plant drawings and make the necessary changes in size of units and order to have a station of the best type known to the art.

The internal combustion or gas engine had from time to time been brought forward as a candidate for position of prime mover, with every prospect of proved economy in fuel consumption; but with the exception of a few special instances it was not looked upon with favor, as shown by the almost universal use of the steam engine.

After a long period of development a new factor in power-plant design; namely, the steam turbine was placed on the market in commercial sizes. It is safe to say that during the last three years no other piece of apparatus has had so stimulating an effect upon the power plant. Its effect upon the entire plant has been most beneficial, for it has revived the apparently moribund superheater. This has now been so developed and improved that superheat of 200° or 300° F. can be safely and economically obtained. With the development of the superheater further study of the problem of combustion has improved the efficiency of the furnace; and this most important subject is apparently susceptible of still further development.

One other important result of the steam-turbine development has been the development of condensing apparatus to such a point of efficiency that a vacuum within 1 in. of the simultaneous barometer reading can now be maintained without difficulty.

Another change in the power plant has been the reversion to high-speed generators, resulting in decreased cost of the generator and its foundations, as well as saving in floor space.

Last, but not least, the steam turbine has put the reciprocating engine and the gas engine on the defensive and has actually been unkind enough to throw out hints in regard to the application of Dr. Osler's proposed methods to the treatment of older apparatus.

The reciprocating engine and internal-combustion engine have not been slow in accepting this challenge; they have responded by showing so improved an economy (especially in the gas engine) that the situation has become most interesting to the power-plant designer. It is safe to say that the developments of the next ten years will show very marked improvement in power plant efficiency.

In regard to this development the author wishes to direct attention to the basic fact that in power plants one should not look merely for increased efficiency in the prime mover, but should also investigate and analyze the entire plant from the coal to the bus-bars; first, in regard to efficiency; secondly, in regard to the effect of load-factor upon investment; and thirdly, the effect of the first and second upon the total cost of producing the kilowatt-hour, which is the ultimate test of the skill of the designer and operator.

EFFICIENCY.

In Table I. will be found a complete analysis of the losses found in a year's operation of what is probably one of the most efficient plants in existence to-day and, therefore, typical of the present state of the art.

TABLE I.—Analysis of the Average Losses in the Conversion of One Pound of Coal Into Electricity.

	B. T. U.	%	B. T. U.	%
1. B. T. U. per lb. of coal supplied	14,150	100.0	.....	.....
2. Loss in ashes			340	2.4
3. Loss to stack			3,212	22.7
4. Loss in boiler radiation and leakage			1,131	8.0
5. Returned by feed-w't'r heater	441	3.1		
6. Returned by economizer	960	6.8		
7. Loss in pipe radiation			28	0.2
8. Delivered to circulator			223	1.6
9. Delivered to feed-pump			203	1.4
10. Loss in leakage and high-pressure drips			152	1.1
11. Delivered to small auxiliaries			51	0.4
12. Heating			31	0.2
13. Loss in engine friction			111	0.8
14. Electrical losses			36	0.3
15. Engine radiation losses			28	0.2
16. Rejected to condenser			8,521	60.1
17. To house auxiliaries			29	0.2
	15,551	109.9	14,099	99.6
	14,099	99.6		
Delivered to bus-bar	1,452	10.3		

DISCUSSION OF DATA IN TABLE I.

ITEM I. HEATING POWER OF COAL.—The thermal value of the coal used is evidently of

*A paper presented at the 203d meeting of the American Institute of Electrical Engineers, New York, Jan. 26, 1906.

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prime importance, as it affects the cost efficiency of the entire plant. **The method of purchasing coal used in the plant from which this heat balance is derived is that of paying for B. T. U. only, with suitable restrictions on the maximum permissible amount of volatile matter, ash and sulphur.**

A small sample of coal is automatically taken from each filling of the weighing hoppers, so that the final sample represents a true average of a boat-load of coal. This final average sample is then pulverized and tested for heat value in a bomb calorimeter, after which a proximate analysis is made of another portion of the sample. This method of purchasing coal has been in use for two years, with highly satisfactory results.

ITEM 2. LOSS IN ASHES.—It is doubtful whether a further saving in this item can be made, as the extra care and labor necessary to accomplish any improvement would in all probability offset the saving in coal.

ITEM 3. LOSS TO STACK.—This is one of the most vulnerable points to attack, as the loss of 22.7% is very large. Recent investigations show that promising results may be obtained by the use of more scientific methods in the boiler room. In practically all cases it will be found that this loss is due almost entirely to admitting too much air to the combustion chamber, resulting in cooling of the furnace. This result is usually produced by "holes" in the fire; these "holes" may be due to several causes, but usually are due to carelessness on the part of the firemen.

Fortunately, a very valuable piece of apparatus has been placed upon the market in the shape of a CO_2 recording instrument. The results of a series of tests made with this instrument are shown in Figs. 1 to 4.

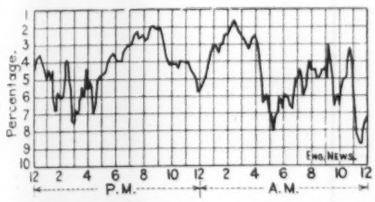


Fig. 1. Boiler No. 29, Forced Draft, Hand Fired, No. 2 Buckwheat Coal. Average % of CO_2, 4.7.

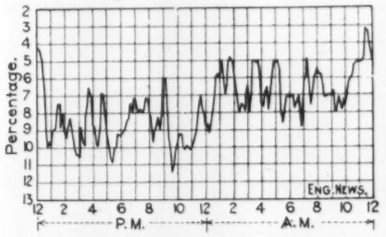


Fig. 2. Boiler No. 29, Under Same Conditions as Fig 1, but with Careful Firing. Average % of $CO_2 = 7.6$.

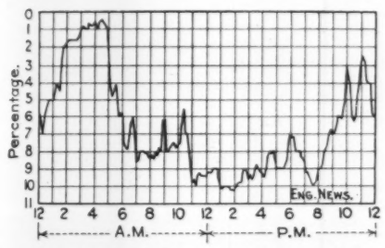


Fig. 3. Boiler No. 31, Stoker Fired, Ordinary Operation. Average % of CO_2, 6.8.

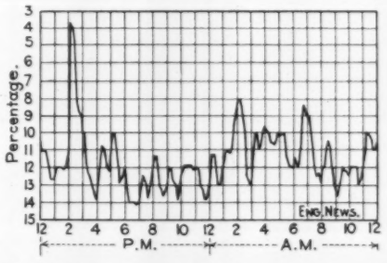


Fig. 4. Boiler No. 31 with Careful Firing. Average % of CO_2, 11.4.

FIGS. 1 TO 4. PERCENTAGE OF CO_2 IN FLUE GASES FOR 24-HOUR PERIODS.

Fig. 1 shows the average condition of a furnace using small sizes of anthracite, with forced draught. The conditions are such that approximately 40% of the thermal value is being lost. Fig. 2 shows what improvement may easily be obtained by watching the CO_2 record, and indicates a saving of about 19% over the previous case. In the combustion of the small sizes of anthracite it is necessary to use a draught of not less than 1.5 in. of water. This breaks the crust of the fire in the thin spots, allowing the air to come through in such volumes that an enormous amount of heat is wasted in raising the temperature of the surplus air and at the same time causing inefficient combustion in the entire furnace.

Fig. 3 shows a record taken from a stoker boiler whilst the recorder was covered up to prevent the fireman from seeing the record. Fig. 4 shows a record taken from the same stoker boiler with the fireman watching the CO_2 indications, resulting in a saving of over 12%. Later records show that even better results than an average of 11.4% of CO_2 can be obtained.

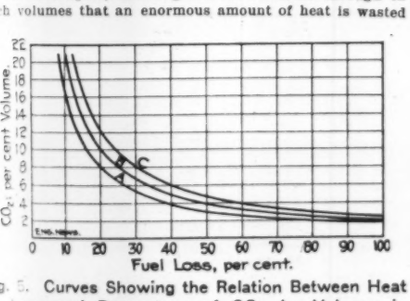


Fig. 5. Curves Showing the Relation Between Heat Loss and Percentage of CO_2, by Volume, in Flue Gas.

Difference between temperatures of entering air and exhaust gas: Curve "A" = 400° F.; Curve "B" = 500° F.; Curve "C" = 600° F.

Fig. 5 shows the calculated losses in fuel corresponding to various percentages of CO_2 for three different temperatures of flue gases.

From a consideration of the above tests it seems reasonable to assume that the 22.7% loss to stack can, by scientific methods in the fire room, be reduced to about 12.7% and possibly to 10%.

Before the installation of the CO_2 recorder a long series of evaporative tests was made to determine the most economical draught to carry when a high-grade semi-bituminous coal was burning on the automatic stokers. The results shown in Fig. 6 were so remarkable that they were repeated under different conditions in order to confirm them. Since the installation of the CO_2 recorder, however, the explanation is apparent; as the draught giving maximum evaporation per pound of combustible corresponds to the point of maximum CO_2, illustrating the inherent difficulty of maintaining efficient conditions in the combustion chamber with high draught. This is well illustrated by Fig. 7, showing the draught, per cent. of rating, and percentage of CO_2.

ITEM 4.—The loss in boiler radiation and leakage, amounting to 8%, is largely due to the inefficient boiler setting of brick which, besides permitting radiation, admits a large amount of air by infiltration. This infiltration will increase with the draught, thus tending to exaggerate the maximum and minimum points on Fig. 6. The remedy for this radiation and infiltration loss is evidently to use new methods of boiler setting, such as an iron plate air-tight case enclosing a carbonate of magnesia lining outside the brickwork.

Mr. W. H. Patchell, of London, has introduced very large boilers, assembling two in one setting; each boiler has a normal evaporation of 33,000 lbs. per hour. In this way he has cut down to a minimum the radiating surface per square foot of heating surface. He has also introduced the iron case with magnesia lining, and with good results.

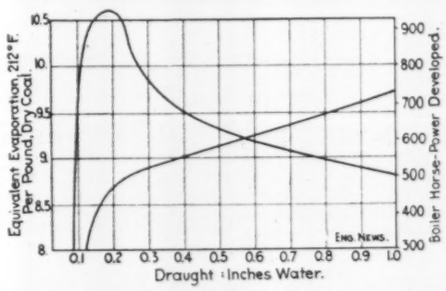


Fig. 6. Curves Showing Relative Economies at Different Draft in the Combustion of Semi-Bituminous Coal Under a Babcock & Wilcox Boiler, Upon a Roney Stoker.

The question of boiler leakage is one in which the choice of the lesser of two evils is necessary; for in the tubular or cylindrical boiler the leakage will undoubtedly be less than in the water-tube type, owing to the smaller number of joints in the water space. But these two advantages are offset by the increased difficulty of construction, and the danger of using large boilers of the tubular type, especially with high-pressure steam. It is now generally admitted that there can be no more difference in the efficiency of different types of boilers under similar conditions than there can be in electric heaters, press agents to the contrary notwithstanding.

ITEM 5. RETURNED BY FEED-WATER HEATER.—The importance of getting the feed-water to the maximum temperature obtainable is generally recognized, and would seem to indicate that all auxiliaries should be steam driven so that their exhaust may be utilized in the feed-water heater; in this way the auxiliaries may operate at about 80% thermal efficiency.

ITEM 6.—Owing to the difficulty of pumping water at temperatures above 150° F., when under pressure, it becomes necessary to install economizers for the purpose of increasing the feed-water temperature to 200° or 250° F. As this increase of temperature is obtained from the waste gases at no expense for fuel, it only becomes necessary to consider the load-factor, as will be shown later, in order to decide whether economizers should be installed or not. In practically all cases where the load factor exceeds 25% the investment will be justified.

In deciding upon the size of economizer to be installed it is important to consider first, the influence of the economizer upon the available draught due to the obstruction it offers and also due to the reduced stack temperature; the second important consideration is to equate the interest and depreciation charges against the saving in fuel, and so determine the amount of investment justified in each particular case.

ITEM 7. LOSS IN PIPE RADIATION.—By the use of two-layer pipe covering, each layer being approximately 1.5-in. thick, and sections put on in such manner that all joints are broken, the radiation losses have become practically negligible.

ITEMS 8 AND 9. HEAT DELIVERED TO CIRCULATING AND BOILER-FEED PUMPS.—As these auxiliaries may be either electrically driven or steam driven it is interesting to note that the thermal efficiency of the electrically-driven pumps would be equal to the thermal efficiency of the plant, multiplied by both the efficiency of conversion from the alternating to direct current and by the motor efficiency. In this case, there would be a net thermal efficiency of $10.3 \times 0.93 \times 0.90 = 8.63\%$, whereas the thermal efficiency of the steam-driven auxiliary discharging its exhaust into a feed-water heater at atmospheric pressure would be approximately 87%.

ITEM 10. LOSS IN LEAKAGE AND HIGH-PRESSURE DRIPS.—The loss in leakage should be infinitesimal, and the high-pressure drips can be returned to the boilers, so that practically all the loss under this heading is recoverable.

ITEMS 11, 12 and 17 are probably unavoidable and of so small a magnitude as not to merit much consideration.

ITEM 13. LOSS IN ENGINE FRICTION.—Recent tests of a 7,500-HP. reciprocating engine show a mechanical efficiency of 93.65% at full load, or an engine friction of 6.35%. As this forms only 0.8% of the total thermal losses it is relatively unimportant. Attention is called to the method of lubricating all the principal bearings by what is known as the flushing system, whereby a large quantity of oil is put through all the bearings by gravity feed from elevated oil reservoirs common to all the units; after passing through the bearings the oil is returned by gravity to oil filters in the basement and then pumped up to the reservoir tanks again. About 200 gallons per hour are put through each engine, and of this quantity

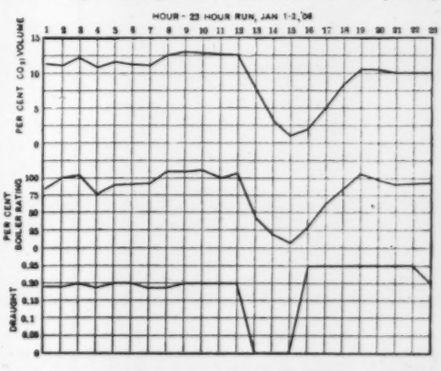


Fig. 7. A Typical Log, Showing Relation Between Draft Boiler Rating and Percentage of CO_2. (Boiler No. 31, Jan. 1-2, 1906.)

only about 0.5% is lost. This method of oiling undoubtedly contributes to the general result.

ITEM 14.—As large electrical generators can now be obtained which give from 98 to 98.5% efficiency, it would seem as if the limit in design had been reached and that hereafter the problem of design is to be merely one of altering dimensions to suit varying sizes and speeds. While this is true as far as the efficiency is concerned, other problems are continually arising, such as the design of generators for an overload capacity of 100% to meet the demand for apparatus capable of taking care of great overloads economically for short periods, corresponding to peak loads of a railroad or lighting plant.

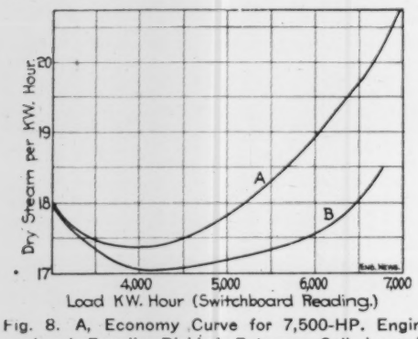


Fig. 8. A, Economy Curve for 7,500-HP. Engine Load Equally Divided Between Cylinders; B, Economy Curve for 7,500-HP. Engine Load Unequally Divided Between Cylinders.

ITEM 15. ENGINE RADIATION LOSSES.—This source of loss has evidently been reduced to a negligible quantity by the use of improved material and methods of heat insulation.

ITEM 16. REJECTED TO CONDENSER, 60.1%.—This immediately introduces the thermodynamics of the steam engine, a subject so broad that it will be impossible to do more than touch upon some of the most important points in considering steam-engine efficiency.

The efficiency of any heat engine can be expressed by the ratio of $E = \frac{T_1 - T_2}{T_1}$ where T_1 is the absolute temperature of the steam entering the engine and T_2 the absolute temperature of the steam leaving the engine. Thus in the engine whose steam-consumption curve is given in Fig. 8, if the initial pressure is 175 lbs. gage and the vacuum at the low-pressure exhaust nozzle is 28 ins., then the maximum thermal efficiency is $\frac{837 - 560}{837} = 33\%$. This would be true for any form of engine or turbine working between the same temperature limits.

In Fig. 8, however, it is seen that the point of maximum economy shows a steam consumption of approximately 17 lbs. per kilowatt-hour, which is equivalent to 20,349 B. T. U. per hour. One kilowatt-hour is equal to 3,412 B. T. U. per hour, so that the actual efficiency of the steam engine and generator is $= \frac{3,412}{20,349} = 16.7\%$.

As the generator efficiency at this load is approximately 98% the net engine thermodynamic efficiency is $\frac{16.7}{0.98} = 17\%$.

The difference between the theoretical efficiency and the actual is then 33 — 17 = 16%, of which 0.8% has

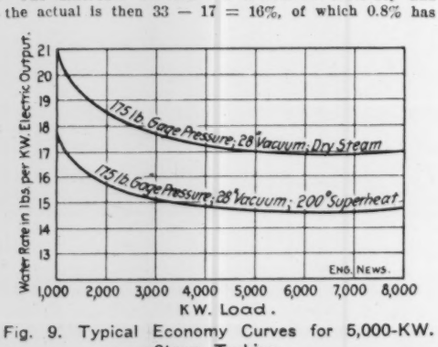


Fig. 9. Typical Economy Curves for 5,000-KW. Steam Turbine.

already been accounted for in engine friction, so that the balance of 15.2% is due to cylinder condensation, incomplete expansion, and radiation.

As the engine friction in a two-bearing engine with high-pressure poppet valves and low-pressure Corliss valves has by careful design been reduced to less than 0.8% of the thermal input, gain cannot be expected here, so attention must be centered on the loss due to cylinder condensation, etc., amounting to 15.2%, in order to effect any improvement.

Superheated steam is the only remedy at hand and with it we can probably effect an improvement of 5 or 6% by using such a degree of superheat in the boilers that dry steam will be had at the point of cut-off in the low-pressure cylinder.

Any greater amount of superheat than this will merely result in loss to the condenser; for it should be remembered that the cylinder losses increase with the difference in temperature between the steam and exhaust portions of the cycle; in other words, the greater the thermal range of temperature the greater the condensation loss. This would seem to point to the use of more cylinders; but this involves additional first cost and friction as well as more space and higher maintenance charges.

SUMMARY OF ANALYSIS OF HEAT BALANCE.

The present type of power plant using reciprocating engines can be improved in efficiency as follows:

Reduction of stack losses	12%
Reduction in boiler radiation and leakage	5%
Reduction in engine losses by the use of superheat.. resulting in a net increase of thermal efficiency of the	6%

entire plant of 4.14%, and bringing up the total thermal efficiency from 10.3% to 14.44%.

THE STEAM TURBINE.

A typical economy curve of a steam turbine is shown in Fig. 9. An inspection of this curve, which represents what is probably the best results obtained up to date, shows: First, that the best economy on dry saturated steam is practically equal to that of the reciprocating engine in Fig. 8; secondly, that 200° superheat reduces the steam consumption 13.5%. But calculating the total heat units in superheat from $H_1 = H + 0.48 (t_2 - t_1)$ the B. T. U. per kilowatt-hour are 20,349 for dry saturated steam, while for 200° superheat they are 19,008 or a net thermal saving of 6.6%. The shape of the economy curve, however, is much flatter than that of the reciprocating engine, so that the all-day efficiency of the turbo-unit would be considerably better than that of the reciprocating engine with the other great advantage of costing approximately 33% less for the combined steam motor and electric generator.

HIGH-PRESSURE RECIPROCATING ENGINE WITH LOW-PRESSURE TURBINE ON ITS EXHAUST.

The inherent principles involved in the design of the steam turbine show that it can be expected to give an almost perfect adiabatic expansion, as there are no thermal cycles of heating and cooling at every stroke as in the reciprocating engine; there is an almost ideal thermal drop from the steam valve to the condenser. It is also evident that the expansion will be relatively more nearly adiabatic in the low-pressure stage of the turbine than in the low-pressure cylinder of the engine, so that it has been proposed that the reciprocating engine should be run high pressure where relatively it is more efficient than the steam turbine, utilizing the turbine for the low-pressure part of the cycle. In other words, use each where it is most efficient.

The following calculations show approximately what might be expected from such a combination. Assuming that the 5,000-KW. reciprocating unit would take 50% more steam when operating non-condensing than when condensing there would then be (see Fig. 8) a consumption per kilowatt-hour of 25.5 lbs.

Steam expanding between the absolute pressure of 190 lbs. and 14.7 lbs. would give up 165.3 B. T. U. per lb., or a total of 4,215 B. T. U. per kilowatt-hour.

The total heat in the steam at 190 lbs. absolute is 1,197, so that the heat units left for the turbine would be $(1,197 \times 25.5 - 4,215) \times 5,000 = 131,542,500$ B. T. U.

The B. T. U. per kilowatt-hour for a turbine unit operating on dry saturated steam (see Fig. 10) were 20,349, but owing to the wetness of the steam at atmospheric pressure the efficiency of the turbine would in all probability be reduced to about 70% so that the steam consumption of the low-pressure turbine would be increased to 29,070 B. T. U. The total power available from the turbo generator would then be 4,807 KW.

We thus find that for a total of 152,617,500 B. T. U. we now get 5,000 KW. from the reciprocating unit, and 4,807 KW. from the turbo unit or a total of 9,807 KW. at a cost of 15,562 B. T. U. per kilowatt-hour.

This turbo unit would be interposed directly between the exhaust nozzle of the reciprocating engine and the condenser, and would have no valves or governing mechanism whatever. The generator would be connected directly to the other generator leads without any switching apparatus, except possibly knife switches to disconnect for testing purposes; and in operation no attention whatever would be required beyond the ordinary lubrication of bearings. Such a unit it is evident could be built at a very small cost per kilowatt-hour.

THE INTERNAL COMBUSTION OR GAS ENGINE.

The gas engine has probably developed more slowly than any other piece of modern apparatus, as it is now thirty years since the Otto gas engine was introduced. It is only within the last ten years that the larger type of engine, from 500 to 2,000 HP. in size, has appeared. The delay in bringing forward the most efficient motive power known is chiefly due to the difficulty experienced in developing an efficient and inexpensive method of making gas. As far as the production of gas from anthracite and non-caking bituminous coals is concerned this problem has apparently been solved, but still in a more or less unsolved condition for richer bituminous and semi-bituminous caking coals of the eastern states.

The following heat balance is believed to represent the best results obtained in Europe and the United States up to date in the formation and utilization of producer gas.

Analysis of the Average Losses in the Conversion of One Pound of Coal Containing 12,500 B. T. U. Into Electricity.

	B. T. U.	Per Cent.
1. Loss in gas producer and auxiliaries	2,500	20
2. Loss in cooling water in jackets	2,375	19
3. Loss in exhaust gases	3,750	30
4. Loss in engine friction	812	6.5
5. Loss in electric generator	62	0.5
6. Total losses	9,500	76.0
7. Converted into electrical energy	3,000	24.0
	12,500	100.0

The great objection to the use of the gas engine for electrical purposes has been: First, its lack of uniform angular velocity; secondly, its uncertainty in action and high cost of maintenance; and thirdly, its inability to carry heavy overloads. Recent developments have removed the first and second objections; and a period of vigorous development has resulted in placing the gas engine in the front rank of claimants for attention as a prime mover.

The total investment for a gas-producer plant, all auxiliaries, gas engines, and electric generators, has been reduced by the elimination of the gas-holding tank to a point where it is now practically on a par with a first-class steam plant using high-grade reciprocating engines.

Where natural gas or blast-furnace gas can be obtained, the gas engine has outdistanced all competitors; and now that some of our large manufacturers have taken up in earnest the problem of designing producer-gas plants, it is safe to say that rapid developments will result.

The records of operation of several important installations of gas engines in power plants abroad and in this country seem to indicate that only one important objection can be raised to this prime mover, and that is that

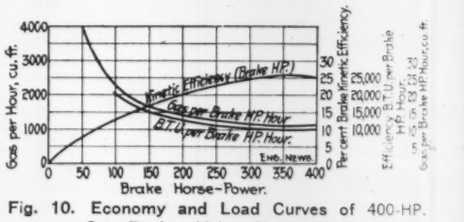


Fig. 10. Economy and Load Curves of 400-HP. Gas Engine Using Natural Gas.

its range of economical load is practically limited to between 50% load and full load, as shown in Fig. 10. This lack of overload capacity is probably a fatal defect for the ordinary power plant, more especially for the average railroad plant operating under a violently fluctuating load, unless protected by a storage-battery of comparatively large capacity.

NEW TYPE OF PLANT.

Over a year ago, while watching the effect of putting a large steam turbine having a sensitive governor in multiple with reciprocating engine-driven units having sluggish governors, it occurred to the author that here was the solution of the gas-engine problem; for the turbine immediately proceeded to act like an ideal storage-battery; that is, a storage-battery whose potential will not fall at the moment of taking up load, for all the load fluctuations of the plant were taken up by the steam turbine, and the reciprocating units went on carrying almost constant load, while the turbine load fluctuated between 0 and 8,000 KW. in periods of less than 10 seconds.

The combination of gas engines and steam turbines in a single plant offers possibilities of improved efficiency while at the same time removing the only valid objection to the gas engine.

A steam-turbine unit can easily be designed to take care of 100% overload for a few seconds; and as the load fluctuations in any plant will probably not average more than 25%, with a maximum of 50% for a few seconds, it would seem that if a plant were designed to operate normally with 50% of its capacity in gas engines and 50% in steam turbines, any fluctuations of load likely to arise in practice could be taken care of.

We have seen that the thermal losses in the gas-engine jacket-water amounted to approximately 19%, and as the water is discharged at a temperature above 100° it can be used to advantage for boiler feed.

The jacket-water necessary for an internal combustion engine will probably be about 40 lbs. per kilowatt-hour, assuming that the jacket-water enters at 50° F., then the discharge temperature will be $50 + \frac{19 \times 12,500}{40 \times 100} =$ 100.4° F.

As the steam turbine will require only about 15 lbs. per kilowatt-hour, including auxiliaries, it is evident that only 7.5% of the jacket-water loss, or 7.1% of the heat input, can be utilized. The other loss in the exhaust gases of 22% can be utilized either in economizers or directly in boilers or superheaters.

Thus by utilizing the waste heat in the gas engines for the purpose of assisting to make steam for the turbines, there could be saved approximately 37% of the total heat lost in the gas engine.

In the summary of analysis of heat balance it was shown that one can reasonably expect to bring the reciprocating engine plant up to a maximum total ther-

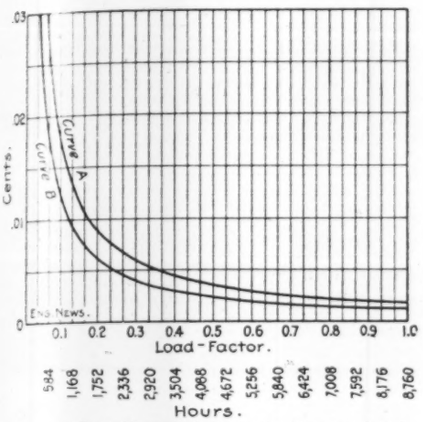


Fig. 11. Fixed Charge Curve with Varying Load-Factor.

Cost of plant per kilowatt (Curve "A").....$130.00
Cost of plant per kilowatt (Curve "B")..... 90.00
Interest, 5%; depreciation, 6%; taxes, 1%; total fixed charges = 12%.

mal efficiency of 14.44%, or possibly with steam turbines using superheat, to 15%.

Referring now to Table I. it will be noted that in Item 2 the loss in ashes was 2.4%, and the loss to stack in Item 3 was 22.7%; now with the hot gases from the gas-engine exhaust it is evident that the loss in 2 will not exist, and that Item 3 will be reduced from 22.7% to about 5% as the process of combustion is completed in the gas engine. The total efficiency of conversion of this 30% of heat from the waste gases when used in the turbine plant would then be 15.0 + 2.4 + (22.7 − 5) = 35.1%.

The heat recoverable from the jacket-water was shown to be 7.1% of the total heat in the coal so that there is 30% + 7.1% = 37.1% of the original heat in the fuel returned from the gas engine, and this can be converted into electrical energy at an efficiency of 35.1%.

For each kilowatt delivered by the gas-engine plant, 3,918 B. T. U. will be simultaneously turned over to the steam plant, and this in turn will give 403 watts to the steam plant free of cost.

The steam plant will then have only to furnish 1,000 − 403, or 597 watts per kilowatt at a thermal efficiency of 15%; in other words, the economy of the steam part of the plant will be raised to $\frac{15}{0.597} = 25\%$.

The average total thermal efficiency of such a combination plant would then be $\frac{24 + 25}{2} = 24.5\%$.

LOAD-FACTOR AND INVESTMENT.

In Fig. 12 the interest depreciation and taxes on a plant costing $130 per kilowatt, which may be taken to represent a first-class steam or internal combustion plant, is shown plotted in conjunction with various load-factors.

Another curve is plotted showing the minimum investment with a plant in which the prime mover would be steam turbines and designed otherwise without regard to efficiency, leaving out economizers, feed-water heaters, etc., and thus reducing the investment to $90 per kilowatt. This cheap and relatively inefficient part of the plant would only be operated on peak loads of two or three hours' duration, corresponding to a load-factor of 0.1 or less found in possibly 40% of the output of our lighting plants.

In Table II. will be found a tabulation of the relative values of the various items necessary in the maintenance and operation of a power plant. The first column covers a plant with compound condensing reciprocating engines without superheat, and is derived from a year's record of actual costs of a large plant operating with a load-factor of approximately 50%; load-factor in this case being defined as

$$\frac{\text{Actual output}}{\text{Maximum hours' load} \times 24}$$

The values in the other columns have in the main been estimated from the first column, but wherever possible actual data derived from various sources, both domestic and foreign, have been used; but in all cases all values have been reduced so as to make them directly comparable with the first column, and with one another. The values in maintenance and operation of steam turbines are derived from actual costs.

SUMMARY.

(1) The present type of steam-power plant can be improved in efficiency about one-fourth by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

(2) The steam-turbine plant has an inherent economy 20% better than the best type of reciprocating-engine plant, not so much due to its higher thermal efficiency as to a variety of causes shown in Table II.

(3) An internal combustion-engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing a kilowatt-hour for less than one-half its present cost.

In conclusion, the author wishes to acknowledge the kindness of the Westinghouse Machine Co., the General Electric Co., and the Allis-Chalmers Co., in furnishing data on steam turbines and gas engines, and also the work of his assistant, Mr. W. S. Finlay, on data and in preparation of curves.

PUBLIC LAND SURVEYS BY GOVERNMENT ENGINEERS IN INDIAN TERRITORY.

By Charles H. Fitch.*

Referring to the contribution on Fraudulent Government Land Surveys in Wyoming, and the editorial on the general subject of public land surveys, both in Engineering News for Jan. 25, 1906, it is probable that very few are aware that an extensive area has been surveyed by engineers employed directly by the Government. This, however, has been accomplished in an efficient and economical manner in the survey of Indian Territory, and a brief statement regarding the work may be of interest to your readers.

The lands held by the Five Civilized Tribes comprise nearly all the Indian Territory, and cover an area of about 31,000 square miles. In order to allot the lands in severalty to the Indians it was necessary to cause a subdivisional survey to be made. Under the provisions of an act of Congress approved March 2, 1895, an appropriation of $200,000 was made for the survey of the lands under the rectangular system. The act referred to provided, further, that the Secretary of the Interior might, in his discretion, place the work under the supervision of the Director of the U. S. Geological Survey, which discretion was exercised. Usually such surveys, whether public lands or Indian lands, are executed under contracts let by the Surveyor-General for the district in which the surveys are to be made, at stipulated rates per linear mile, as fixed by law. In this case there was no surveying district in Indian Territory, and, therefore, no serious objection was made to the proposed departure from the usual method.

April 1, 1895, the first parties were in the field. Two parties were engaged in establishing the standard meridians and parallels at intervals of 24 miles; six parties were engaged in running township exteriors within the blocks bounded by standard lines; and four parties, each consisting of two camps, with two surveyors or transitmen in each camp, were engaged in the subdivision of townships. The force was materially increased as the work progressed. Each of the subdivision parties was placed under the control of a topographer of the regular force of the U. S. Geological Survey, whose duty consisted in the inspection of the work of the land survey and the preparation of the topographic maps. Additional appropriations were made from time to time, the total amount being $671,500.

Iron posts with brass caps were placed at every township corner. These monuments are 4 ins. in diameter, 4 ft. long, and are set 3 ft. in the ground. In addition to the usual marks referring to township, range and section, the elevation above sea level was marked upon the brass cap of such posts. The elevations were determined by means of spirit levels. Prior to beginning the work upon the township lines, double lines of levels were run over the tracks of all of the railroads then traversing the country, with frequent bench-marks as checks to the township lines crossing them. Then level lines were run over all of the east and west township lines and many of those running north and south. The datum point for the level work is a bench-mark established at Fort Smith, Ark., by the U. S. Coast & Geodetic Survey.

A system of triangulation was carried over the area surveyed, which served as a basis for the topographic survey, and as a means of checking and correcting errors in the rectangular survey. It will also assist in the recovery of missing corners should they become lost or disappear in after years, as the triangulation stations are located upon the highest points and prominent natural objects.

The topographers mapped the topography of the area subdivided. They first plotted upon the field sheets the objects noted by the surveyor, including the crossing of streams, roads, the base and summits of hills, ridges or mountains. The elevations of the exterior lines being furnished by the levelmen, additional elevations were obtained by means of vertical angle stadia lines run through the interior of the townships and checked upon the levels.

In the land survey 63,881 miles were run, as follows: Standard lines, 2,491 miles; exterior lines, 7,777 miles; subdivision lines, 50,931 miles; meander lines, 2,149 miles; boundary lines re-established, 533 miles. In addition, level lines were run as follows: Railroad levels, 1,613 miles; other level lines, 7,690 miles. Vertical angle lines were run over 8,595 miles. The total mileage of the land survey, level and vertical angle lines, was 81,778.

The Geological Survey not only executed the land or subdivision survey of the area, but, in addition, carried on the triangulation, the topographic survey, including many miles of spirit level lines, and also set the iron posts or bench-marks at all township corners, a labor not required of contractors. The topography of Indian Territory was surveyed on a field scale of 2 ins. to the mile, and has been published on a scale

*Executive Officer, U. S. Reclamation Service, Washington, D. C. We are indebted to Mr. A. P. Davis, Acting Chief Engineer of the U. S. Reclamation Service, for the following statement regarding Mr. Fitch's experience in government land surveys and similar work:

"Mr. Fitch has had over 30 years' experience in Government survey work, having been Deputy Land Surveyor in New Mexico in the 70's, and later Inspector of Surveys for the General Land Office. He has also had an extended experience as Deputy Chief of the Survey Division of the General Land Office in Washington, and was for several years topographer in the U. S. Geological Survey. He had entire charge of and successfully conducted the rectangular and topographic survey of the Indian Territory, described in his communication, and has stated the facts with conservatism and modesty."

TABLE II.—Distribution of Maintenance and Operation. Charges per Kilowatt-Hour in Percentages.

	Reciprocating engines.	Steam turbines.	Reciprocating engines & steam turbines.	Gas engine plant.	Gas engines and steam turbines.
Maintenance.					
1. Engine room mechanical	2.57	0.51	1.54	2.57	1.54
2. Boiler room or producer room	4.61	4.30	3.52	1.15	1.95
3. Coal and ash-handling apparatus	0.58	0.54	0.44	0.29	0.29
4. Electrical apparatus	1.12	1.12	1.12	1.12	1.12
Operation.					
5. Coal and ash-handling labor	2.26	2.11	1.74	1.13	1.13
6. Removal of ashes	1.01	0.94	0.80	0.53	0.53
7. Rock rental	0.74	0.74	0.74	0.74	0.74
8. Boiler-room labor	7.15	6.68	5.46	1.79	3.07
9. Boiler-room oil, waste, etc.	0.17	0.17	0.17	0.17	0.17
10. Coal	61.30	57.30	46.87	26.31	25.77
11. Water	7.14	0.71	5.46	3.57	2.14
12. Engine-room mechanical labor	6.71	1.35	4.03	6.71	4.03
13. Lubrication	1.77	0.35	1.01	1.77	1.06
14. Waste, etc.	0.30	0.30	0.30	0.30	0.30
15. Electrical labor	2.52	2.52	2.52	2.52	2.52
Relative cost of maintenance and operation	100.00	79.64	75.72	50.67	46.32
Relative investment in per cent	100.00	82.50	77.00	100.00	91.20

of two miles to the inch, with a contour interval of 50 ft., all of which has been accomplished at a great saving to the Government from the amount which it would have cost to make the land survey alone, under the contract system.

A portion of Indian Territory is prairie and an easy country to survey, but at least two-thirds of it is timbered, rough, rugged and in some portions mountainous. During a portion of the year it is an unhealthy country, and particularly during the fall months malarial fevers are prevalent. The summers are extremely hot, but the work was carried on throughout the year. As before stated, the survey was begun April 1, 1895, and it was completed July 1, 1898, a little over three years.

At the contract rates per mile the land survey would have cost about the amount of the appropriation, but without the topographic survey. To have mapped the area in question independently would have cost at least $200,000, which was therefore saved. About $15,000 was left out of the appropriation, and also an equipment of instruments, animals, wagons and camp material.

While it was possible in this case, and may be so in other large areas, to compete with the contract rates of mileage, it is not probable that it could be done in isolated small tracts, although by the method used in Indian Territory accurate, well-marked surveys would be the result, and if the work is worth doing it is worth doing well.

While it is undoubtedly true that more accurate surveys are in most instances now being made because of official examination, still there is much delay and expense caused by the present methods. The latest report of the Commissioner of the General Land Office shows that a large number of contracts involving surveys made, some of them dated in 1895, are still pending. In the same report it is noted that the sum of $20,000 was apportioned to Colorado for resurveys of townships opened for settlement many years ago, "but in which the defective or fraudulent nature of the original work made it an act of justice and necessity to provide actual boundaries."

Good surveys have been made in many of the Western States, particularly where the work was easy; but in almost every instance not enough attention has been paid to the permanency of the monuments, and unless there followed early settlement the marks were generally lost or obliterated.

THE OFFICE SYSTEM OF THE CHIEF ENGINEER OF STREETS; CHICAGO.*

By John B. Hittell.†

The Chief Engineer of Streets of the city of Chicago is independent of the other engineer officers of the city and reports directly to the Board of Local Improvements. This board consists of five members, four of whom are appointed directly by the Mayor, and a Secretary who is ex-officio a member by virtue of being Superintendent of Special Assessments.

During the year 1905 there were paved approximately 95 miles of streets at an aggregate cost of $3,500,000. The force assigned for this work consists of one chief engineer, five assistant engineers in charge of divisions (who have for their help assistant engineers and rodmen), eight general inspectors, one brick tester and one cement tester. From time to time, as the work progresses, about 75 sub-inspectors are assigned to the work, whose duty it is to pass upon and direct the same as performed, with such assistance and direction as the general inspector and assistant engineer, or other superior officers may give them. It will be readily seen that the chief engineer cannot give any marked attention to any individual piece of construction, but is engaged mostly in the executive part of the business.

An improvement originates in one of three ways, namely: By petition from the property owners to the board, by an order of the city council, or by a member of the board. Any such proposed improvement is referred to the chief engineer for report and recommendation. After the same has been assigned to the proper division engineer, his report is made on the form shown in Fig. 1, which is 8½ × 7 ins. If the report is concurred in by the board, an estimate is ordered and plats are obtained from the Map Department for the preparation of the estimate. The estimate is itemized no more than is necessary in accordance with the decisions of the courts on the law, and generally shows the amount or lineal feet of curbing to be done, cubic yards of grading and square yards of paving, all at unit prices, and a lump sum for the adjustment of catch basins and manholes; together with such new catch basins and manholes as may be necessary to be built. All these make an elastic sum, so that the total amount of the improvement will be multiples of $500, the object of this being to simplify the clerical work when spreading the assessment rolls into five annual installments. Accompanying the engineer's estimate is a description of the proposed improvement, showing the limits, together with any exceptions which may be necessary, and the established grades, so that

BOARD OF LOCAL IMPROVEMENTS.
BUREAU OF STREET ENGINEERING.

ENGINEER'S REPORT.

Chicago, 190

Paving from
to with
Has street ever been paved? When?
With what material? Present condition
Is sewer in street?
Do you recommend the extension of the improvements beyond the limits proposed; if so, give points
Do you recommend improvement of street at this time?
Remarks:
Approved:
Assistant Engineer.
Chief Engineer of Streets.

Fig. 1. Form of Engineer's Report on Proposed Street Improvements (⅛ Size).

the special assessment department may properly draw an ordinance.

Upon notification from the law department that the assessment roll has been confirmed for an improvement, the department sends to the various bureaus of the city a tracer of the form shown in Fig. 2. From the information derived, together with the amount and character of the work, the engineer is in a position to know approximately when such an improvement can be completed, which time is inserted and made part of the specifications. This tracer is attached to the specifications and made a part thereof. All proposals, being addressed to the Board of Local Improvements, are canvassed by it and the figures referred to the Chief Engineer for tabulation and report. If three or more regular bids are received, the lowest three are tabulated on the second sheet of the tracer (Fig. 3) for the board's information, and the Chief Engineer is informed of its action in the matter.

After the contract is awarded the various departments are at once notified of such an award and are informed as to the time given to the contractor to do the work. The parties notified include the Superintendent of Streets, by whom all permits are issued to the public utility corporations who desire to do work on the street; the City Electrician and the Superintendent of Water Pipe Extension. A memorandum of such an award is sent to the gas companies, telephone company and electric lighting companies. On streets where car tracks are to be adjusted, the Commissioner of Public Works is notified of such a fact and the companies are requested to apply to him for a permit to adjust the same. Upon the signing of the contract, the main items of same are put upon the index card form shown in Fig. 4 (6 × 4 ins.); this shows the name of street, the limits, the individual items of the contract, total amount of the assessment, contractor's name, date of contract and time set for the completion of the work, together with name of engineer in charge of the work and that of the general inspector in whose district the work lies.

The number of contracts averages about 500 and these cards are constantly in use by the Chief Engineer as reference. Upon the completion of the work, the date of the commencement and the date it was finished, together with the final contract quantities and the length of the improvement, with a memorandum as to whether the pavement has replaced a previous pavement, is put thereon and this card is then placed in a temporary yearly file and used at the end of the year in preparing the annual report and the statistical tables necessary thereto.

When a contractor desires to commence operations, application is made to the Chief Engineer, and sub-inspectors are assigned to the work. These inspectors having been furnished with a copy of the specifications, report directly and daily to the Chief Engineer by postal card. This report, after indicating the name of the street under contract, states the amount of work done that day, where performed, total amount of work done to date and balance to be done; also such other information as he may deem necessary, namely: whether fire hydrants, telephone or car poles are in the way of the improvement, or anything unusual which might be of interest to the department. In case of an accident, he is instructed to get all the information he can, with names and addresses, and report in full thereon; a copy of this is sent by the Chief Engineer to the City Attorney, so that the city may be fortified in case a damage suit is instituted against it.

If the character of the improvement is such that the cement test is used, the contractor notifies the cement tester of the location of the warehouse in which the cement he proposes to use is stored, and an employee is sent for the purpose of taking one sample from each twentieth bag, or barrel, and stenciling the same by numbers. The order of the print is changed yearly so that no cement which has been tested the previous year will be included in the work. The cement is subjected to the following tests: Soundness, fineness, setting and tensile (neat and with sand). If the cement is of a brand which has been used by the department, it is subjected to a 7-day tensile test; otherwise no cement is used unless 7-day tensile tests have been extended to a year. The cement tester reports to the Chief Engineer on a printed form, and keeps a carbon copy thereof for his own use.

When accepted cement is needed upon the work, the cement tester assigns a sampler and shipper to the warehouse, who superintends and checks the shipment given to the teamster, delivering to him a certificate for the sub-inspector on the street, which certificate states the date of delivery, name of the cement, the numbers, and generally contains a notation as to whether the same is to be used as foundation concrete or exposed concrete. This certificate is given by the teamster to the sub-inspector and is an authority for him to use the cement on the work, and he in turn sends the certificate to the cement department, where the same is kept for record as to the amount of material used. Should only part of the shipment be used on one job, the inspector then notes on the back of the certificate this fact, which notation in turn authorizes the sub-inspector on the other work to accept and use the cement. There were tested during the year 1905, 254,530 barrels of cement, of which 4,070 barrels were rejected. To accomplish this work the cement tester has, acting directly under him, about nine cement samplers and shippers at the height of the season.

During the progress of the work, estimates are issued upon the certificate of the division or assistant engineer and vouchers showing the distribution of the amount au-

BOARD OF LOCAL IMPROVEMENTS.

Street No.
Letting No.
Chicago, 190
Reports of Heads of Bureaus relating to the improvement of
from to

BUREAU OF SPECIAL ASSESSMENTS.
Total amount available for said improvement,
Prices on which the assessment is based,
Date of confirmation of assessment,
Is the assessment on the installment or one-year plan?
Any reason why improvement should be delayed?

BUREAU OF ENGINEERING.
Are Water Mains laid in said street?
Are they sufficiently low to prevent freezing?
Is it necessary to lay larger pipe?
If so, when will the work be completed?

ASSESSOR WATER OFFICE.
Are the Water Service Pipes laid?
Are they reported for assessment?
Is the assessment confirmed?
Are they under contract?

BUREAU OF STREETS.
Are there any wires to be put under ground?

CITY ELECTRICIAN.
Have you any conduit work to do?
If so, when will work be completed?

SEWERS AND DRAINS.
Are Sewers laid, or under contract?
Are Drains laid, or under contract?
Are they reported for assessment?
Is the assessment confirmed?
Is there any work to delay the improvement?

REMARKS.

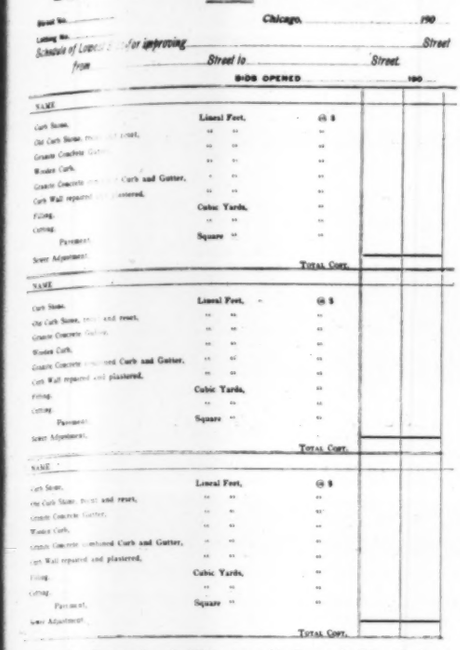
Fig. 2. Reports of Heads of Bureaus on Proposed Street Improvement (⅛ Size).

thorized by the division engineer are drawn by the voucher clerk and signed by the division engineer, chief engineer of streets and the other city officials as prescribed by law. A certificate of the division engineer showing the amount that is due is made in the form shown in Fig. 5 (8½ × 11 ins.), and at a glance it will be seen that it readily shows the percentage of the amount of the work performed to date of issue to the total amount of the contract.

Upon the completion of the work a final estimate is-

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, Rockford, Ill., Jan. 17, 19, 1906.

†Chief Engineer of Streets, City Hall, Chicago.


BOARD OF LOCAL IMPROVEMENTS.

Chicago, 190

Schedule of Lowest Bids for improving Street from Street to Street.

BIDS OPENED 190

NAME			
Curb Stone,	Lineal Feet,	@ $	
Old Curb Stone, reset and reset,	" "	"	
Granite Concrete Gutter,	" "	"	
Wooden Curb,	" "	"	
Granite Concrete combined Curb and Gutter,	" "	"	
Curb Wall repaired and plastered,	" "	"	
Filling,	Cubic Yards,	"	
Cutting,	" "	"	
Pavement,	Square "	"	
Sewer Adjustment,			
	TOTAL COST,		

NAME			
Curb Stone,	Lineal Feet,	@ $	
Old Curb Stone, reset and reset,	" "	"	
Granite Concrete Gutter,	" "	"	
Wooden Curb,	" "	"	
Granite Concrete combined Curb and Gutter,	" "	"	
Curb Wall repaired and plastered,	" "	"	
Filling,	Cubic Yards,	"	
Cutting,	" "	"	
Pavement,	Square "	"	
Sewer Adjustment,			
	TOTAL COST,		

NAME			
Curb Stone,	Lineal Feet,	@ $	
Old Curb Stone, reset and reset,	" "	"	
Granite Concrete Gutter,	" "	"	
Wooden Curb,	" "	"	
Granite Concrete combined Curb and Gutter,	" "	"	
Curb Wall repaired and plastered,	" "	"	
Filling,	Cubic Yards,	"	
Cutting,	" "	"	
Pavement,	Square "	"	
Sewer Adjustment,			
	TOTAL COST,		

Fig. 3. Record of Bids on Proposed Street Improvements (1/3 Size).

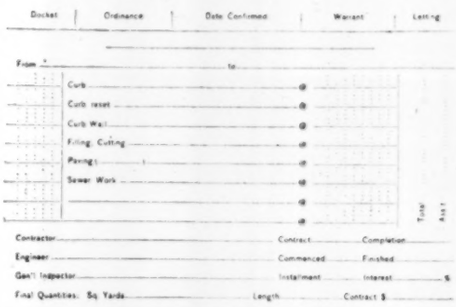
sued in the same manner as the original estimate of the engineer. The certificate for the amount of the money due the contractor upon the completion of the work also has a notation showing the width of the roadway; if this is different from the width prescribed in the general ordinance establishing the width of roadways for streets of different widths, it is entered in a book containing the special roadway widths. The engineer also notes the length of the improvement in feet and whether or not the present pavement has replaced another pavement. These notations are entered upon the index cards and as streets are finished these cards are transferred from the every-day working file to a temporary index to be used at the end of the season for the compilation of the annual report, and are finally transferred to one general file. For ready reference a Donnelly's atlas of the city of Chicago on a scale of 200 ft. to the inch is posted, using different colored pencils for different classes of pavement and marked with the year in which the pavement was completed.

Prior to the expiration of the period of guarantee on an improvement, the contractor is notified in a communication to make any necessary repairs. This notification is sent about six weeks or two months before the end of the guarantee period and is usually in the form of a letter. An examination of the improvement is made 15 days before the expiration of the guarantee period and if repairs are needed, the contractor is officially notified to make the repairs within the time set in the notice. Should no attention have been paid to the above notice, the bondsmen are notified, all such notices being sent prior to the expiration of the date of the contract for legal reasons. Should the surety company not cause the repairs to be made, the Board of Local Improvements is furnished a statement to that effect, together with an estimate of the cost of the improvement, which is made the basis of the suit against the surety company.

All letters, reports, etc., are duplicated with carbon copies, and the vertical filing system is in use wherever possible. Letter-press copies are not used because it is more convenient to have the original communication with a carbon copy of the reply attached to it.

PROPOSED STANDARD SPECIFICATIONS FOR THE MANUFACTURE OF HOLLOW CONCRETE BLOCKS.

Many concrete block machinery manufacturers have placed in the hands of their customers so much unreliable information in the way of specifications and estimates of cost of hollow concrete blocks that at its meeting of June, 1905, in Chicago, Ill., the National Association of Machinery Manufacturers appointed a committee on Standard Specifications. This committee has prepared a set of specifications which has been placed in the hands of all block machinery manufacturers


Docket | Ordinance | Date Confirmed | Warrant | Letting

From " to

Curb @

Curb reset @

Curb Wall @

Filling, Cutting @

Paving @

Sewer Work @

@

@

Total Amt.

Contractor Contract Completion

Engineer Commenced Finished

Gen'l Inspector Installment Interest $

Final Quantities: Sq. Yards Length Contract $

Fig. 4. Form of Index Card.

with the request that they be used in basing their estimates of cost and output. These specifications give a concise code of rules for manufacturing concrete blocks that will be of interest and value to many, and we publish them herewith:

DEFINITIONS.

SAND.—Such material as will pass through a screen ¼-in. mesh and is retained in screen having a No. 40 mesh. This applies to river sand, bank sand, or screenings from a stone crusher.

GRAVEL.—Material obtained either from a bank or river, of such size as is retained in a screen having a ¼-in. mesh.

CRUSHED STONE.—Such stone from a crusher as is retained in a ¼-in. screen.

BANK GRAVEL.—Such material as is obtained from a pit or river containing both sand and gravel.

AGGREGATE.—Any material such as broken stone, gravel, or such fragments used with cement and sand mortar in making concrete for the purpose of reducing the cost and adding to the strength.

VOIDS.—The space existing between particles of sand, crushed stone, or materials of which an aggregate is composed.

CEMENT.—Any Portland cement, which will pass the tests required by The American Society for Testing Materials.

QUALITY OF SAND.

Sand suitable for concrete work must not be finer than the above-described; must be sharp and gritty; not soft or loamy; must be free from loam or other foreign material, and must not contain any perceptible amount of clay, or other soluble matter. Some authorities concede that clay to the extent of 10% in sand or gravel is not harmful. This committee is of the opinion that any perceptible amount of clay is unsafe. Crushed stone must be reasonably free from dust and must be retained on the same size screen as bank sand, viz., ¼-in. Gravel or crushed stone must be free from loam, dust or other foreign material, and must contain no soft or rotten stone.

DETERMINATION OF AMOUNT OF CEMENT TO BE USED WITH AGGREGATE.

A theoretically correct concrete should consist of sand and gravel, or crushed stone, or a combination of them, containing any amount of cement equal to the voids in such combination. In other words, interstices should be filled with cement. To state this in another way, if the concrete is made up of sand and gravel, such proportion of cement should be used with the sand as is equal to the voids in the sand, and such quantity of this resulting mortar of sand and cement should be used with the crushed stone or gravel, as will fill all voids in the crushed stone or gravel.

Re-stating this in a few words, the cement should fill the voids in the sand, and the resulting mortar should fill the voids in the aggregate.

DETERMINATION OF VOIDS.

To determine the voids in the sand, or the material to be used as an aggregate what is know as the "water test" is employed. In preparing for this test the sand or gravel must be perfectly dry. Sand has greater volume when wet.

A receptacle holding a known amount, such as a quart jar, is filled with the material to be tested, sand for example, and into this receptacle is poured as much water as the sand, or other material will absorb. The water should be measured. The amount of water absorbed indicates the voids, and also indicates the exact amount of sand which it is necessary to use in order to produce a solid concrete.

In making hollow blocks, if no gravel or other coarse aggregate is used, the result of this test should give the proportions of sand and cement to be used in block manufacture. Average sand will absorb 25 to 35% of water, indicating from 25 to 35% of voids; also indicating that the proportion to one part of cement to from three to five parts of sand are required to make a solid block.

The proper selection of sand and aggregate material is important. Care should be taken that the particles vary so in size as to reduce the voids to the smallest amount possible. With this careful selection the amount of cement required to produce good work is greatly reduced.

MIXING.

After the materials are selected they should be mixed together dry, until thoroughly incorporated, or in other words, until the mass is of an absolutely uniform color. Water should then be applied, and the thorough mixing repeated. The amount of water should be in all cases as great as possible, without causing the materials to stick to the molds when the stone is removed. A little more care in the treatment of the face plates of any machine will enable the manufacturer to use a wetter concrete than is usually employed. Only such size batches should be mixed at one time as can be used up within 30 minutes from the time the water has been added.

MANUFACTURING.

The concrete should be placed in the mold in small quantities, and tamping should begin immediately upon the placing of the first shovelful, and continue until the mold is full. The material should be tamped with a

Board of Local Improvements.

Chicago, 190

JOHN B. HITTELL, CHIEF ENGINEER.

DEAR SIR,—

As applied for a estimate on contract for improvement of

Transcript of Contract.

lin. ft. of curb @ $

lin. ft. of curb reset @

lin. ft. of curb wall plastered and repaired @

lin. ft. of curb wall @

cu. yds. of cutting @

cu. yds. of filling @

sq. yds. of paving @

Cost of adjusting sewers

Asst. Engineer's Estimate of Work Done to Date.

lin. ft. of curb @ $

lin. ft. of curb reset @

lin. ft. of curb wall plastered and repaired @

lin. ft. of curb wall @

cu. yds. of cutting @

cu. yds. of filling @

sq. yds. of paving @

Cost of adjusting sewers

Less reserve 15% as per contract

Less amount paid on former vouchers

Net amount due contractor

Respectfully submitted,

Assistant Engineer.

Fig. 5. Form for Assistant Engineer's Report on Progress of Work (1/3 Size).

tamper having a small face, and short, quick, sharp blows should be struck.

In faced blocks the face should be composed of two parts sand and one part of cement, the same being mixed in the manner described above.

Owing, however, to the excess of cement used in facing, and owing further to the fact that the cement is what makes concrete sticky, the facing cannot be used as wet as the balance of the block is made. Great care should be taken to tamp the concrete thoroughly into the facing, so as to unite the two into one solid stone.

In the wet process the amount of water used is such as will produce a plastic, or flowing condition, in the concrete, but not enough to wash the cement from the other material. When placing the material in the molds the entire mold is filled with one pouring.

No stone having transverse ties or webs cracked should be used, or even allowed to cure. Should a slight crack occur in moving the green stone, throw the material back, and make it over. In no case use a cracked stone in a building.

CURING.

All stone made by the medium wet, or medium dry process, should be made under cover, and kept under cover for at least ten days, protected from the dry currents of air. If shed room is not available to store a ten days' output, the blocks should be carried out after the initial set has taken place, and covered with canvass, hay or other covering, which will retain moisture, and at the same time keep the dry air from circulating around the block. Under no circumstances should blocks be made under the direct rays of the sun, nor should blocks made by this process be exposed to either sunshine or dry winds while curing.

The blocks should be gently sprinkled as soon as possible after making, that is, just as soon as the cement has set sufficiently so that it will not wash. Blocks should be kept wet from ten days to two weeks, and should never be removed from the yard for the purpose of using in a building until they are from 30 to 60 days old. This is very important. A green block will surely crack in the building on account of shrinkage.

LAYING.

In laying cement stone a soft mortar composed of ½ cement mortar and ½ lime mortar should be used. This mortar should be made with fine sand free from stone, and should be buttered on the ends of the stone before laying. The stone should be laid in the mortar and work down. Do not leave end joints open until after the building is completed, because when the end joints are filled at this time shrinkage in mortar is liable to loosen it, causing the mortar to fall out, leaving openings through the wall. The spreading of mortar is very important, because if mortar is unevenly spread so that it is thicker under one portion of the stone than under the other, a leverage is created, which under the weight of the wall above is liable to produce a crack in the stone.

COLORING.

In using coloring matter with concrete, the color should always be mixed with the cement dry, before any sand or water are added. This mixing should be thorough, so that the mixture is uniform in color. After this mixing the combination is treated in the same way as clear cement.

HIGHWAY IMPROVEMENTS IN NEW YORK STATE.

The State of New York has entered upon some extensive highway improvements, on its own account, and has passed some laws designed to effect improvements in road work done by local authorities. Last November an amendment to the State constitution, authorizing State bond issues up to $50,000,000 for road improvements, was approved by popular vote. Already much road work has been done and the cost defrayed from the proceeds of taxation. Some interesting information on this and allied subjects

is given in the annual report for 1905 of Mr. Henry Van Alstyne, State Engineer.

From January, 1898, to Dec. 1, 1905, no less than 6,900 miles of road improvements had been petitioned for, and of this 2,038 miles had been approved by county supervisors and 704 miles actually constructed. The 1,334 miles approved and awaiting construction, it is estimated, would cost $12,627,398. Of this the county supervisors have appropriated one-half, but the State has not yet provided anything towards the other half. Before the legislature of 1906 adjourns other proposed improvements to the extent of $1,000,000 are likely to be approved, making a total appropriation of $7,000,000 incumbent on the present session of the legislature.

For maintenance of roads improved by State aid Mr. Van Alstyne recommends that the State do the work, meeting the cost from

the taxes now paid by the abutting property owners and from a tax to be paid by owners of automobiles for licenses, supplemented by such State money as might be necessary to keep the roads in a proper state of repair.

The production of crushed stone by convict labor is recommended by the State Engineer, as follows:

It is probable that in the near future the State will have to provide a new prison. I would respectfully recommend that the site of this prison be located where the able-bodied male prisoners may be usefully employed in operating a plant for crushing stone to be used in the building and repairing of state, county and town roads and such other public improvements as may require the use of broken stone. During the construction of the barge canal there will be millions of cubic yards of rock excavated at different places along the line of the canal and placed in spoil banks, where under the terms of the contract, the excavated rock remains the property of the state. I would suggest that the site of the prison be

Fig. 1. Track Drill in Place for Work. Kalamazoo Railway Supply Co., Kalamazoo, Mich., Makers.

located on the west bank of the Hudson River where trap rock can be used without injury to the scenery of the Palisades, or adjacent to one of the spoil banks where the stone necessarily excavated for the barge canal may be crushed for use on the public roads and works of the State.

Shade trees on State-improved roads are recommended. They would lessen raveling, and thus decrease maintenance, besides adding to the beauty of rural districts. Legislation is needed to permit tree planting at State expense.

It is encouraging to note that the money system of road repairs has been substituted for the old labor system in about 450 towns, containing some 40,000 miles of roads, or over half the mileage of the State. Thirteen counties have elected county engineers or superintendents of highways. Where this has not been done the State Engineer's Department has endeavored to ascertain the methods under which "the State and town money is expended."

On the important subject of a uniform system of town road and bridge reports and accounts Mr. Van Alstyne says:

In order to provide a uniform system of reports and accounts to show exactly when, where and to whom all moneys were paid for highway purposes, suitable blanks and stationery have been placed in the hands of town officials and they will be required to properly fill out these blanks before the state money is given them for the coming year. Nearly $5,000,000 is now expended annually by the highway commissioners of the towns of the state in the improvements and repairs of highways and bridges. It is of the utmost importance that this money be expended in the most economical and efficient manner in order to secure the best results to the taxpayers. This department has endeavored, with the assistance of the various county engineers, superintendents of highways, and the inspectors of highways appointed by the State engineer, to so advise and direct the local officials under whom this money is expended as to secure for the people the best possible results for their money.

In the 450 towns that have adopted the money system the various highway commissioners previous to the adoption of this system had not expended any large sums of money while working under the labor system and it was found that a different system of accounting existed in every town and that none of the systems was such as could be approved by this department. In order to correct this serious defect in our highway administration we have endeavored to make sure in the past, and shall insist in the future, that all accounts be kept upon standard forms prepared by this department. These will permit comparisons between the different towns.

A NEW DESIGN OF TRACK DRILL.

A track drill which is specially designed for use in yards and on busy roads where it is important that the work should be done without interrupting traffic and without incurring risks, is illustrated in the accompanying cuts. Its special feature is that the upright portion carrying the crank handles can be almost instantly lowered, without removing the lower part or the drill. In this way, if the work is interrupted by a train the machine can be promptly made clear of the track and the work then resumed at once without the delay of adjusting the machine to an unfinished hole. The tool can be set on either side of the rail, and may be fitted with clamps attaching it either to the head or the base of the rail. The latter arrangement is shown in Fig. 1, and is in general preferable, as it is safer to have no obstruction upon the rail at any time. Fig. 1 shows the machine in position for drilling: Fig. 2 shows it with the upright removed, leaving the lower part (with the drill) in place. The clamp in the latter case, however, is of the form adapted to fit over the head of the rail.

The construction is clearly shown in the views. The upright column carries the driving shaft, with the upper pair of bevel gears and one of the lower bevel wheels; attached to it is a brace which is hooked to the back of the horizontal frame, and made tight by a clamp which can be immediately released. The machine is fitted with a variable-speed gear to meet the varying conditions, such as drilling with large or small drills, in hard or soft steel, reaming holes for electric bonds, etc. By throwing the feed mechanism out of gear, the drill bit can be quickly fed up to or withdrawn from the work. Ball thrust-bearings are used on the spindle, thus materially reducing the friction.

This machine is known as the Moore track drill and is manufactured by the Kalamazoo Railway Supply Co., of Kalamazoo, Mich.

A SEWER PIPE CENTERING DEVICE.

By H. P. Shoemaker.*

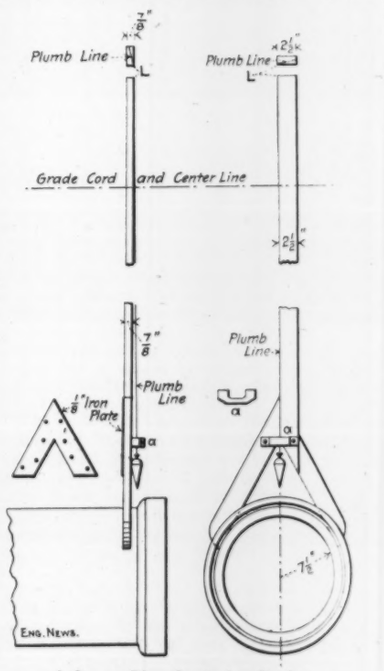
The accompanying sketch shows a device for centering sewer pipe in the trench while being laid. It is based on the principle of the centering square. During October and November, 1905, I used this device in laying two lines of pipe sewer, one 20 and one 15 ins. in diameter, and with it did work as nearly accurate as may well be.

FIG. 2. UPRIGHT PORTION OF TRACK DRILL REMOVED TO CLEAR TRAINS.

(The lower part, with the drill remain in place.)

The device is light and is easily handled, being made of straight-grained yellow pine, and when set astride the body of the pipe will do its work regardless of variation in diameter of pipe.

In manipulation the device is set astride the section of pipe in hand, the edge of the straight edge with plumb line brought in very easy contact with the grade cord and center line, after which the section of pipe is shifted laterally until the plumb line cuts the joint of the left leg and straight edge, or until the plumb line parallels the left edge of straight edge. The



A Sewer Pipe Centering Device.

plumb line should be hung from a point on the straight edge, but an inch or two above the point where the grade and center cord cuts the straight edge.

THE CHICAGO DRAINAGE CANAL BOARD has decided to discontinue work on the widening of the South Branch of the Chicago River to 200 ft., and to employ all available funds in acquiring the right-of-way for the Calumet and Evanston channels. The river improvement plant was adopted in 1901, and about 80% of the work has been done, while the cost of completing it is estimated at $3,000,000. It is suggested that the government will be asked to complete the work on the river.

*Lock Haven, Pa.

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ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
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Copy for regular, or "Contract," Advertisements should be received one week before publication; "For Sale" and "Situations Wanted" Advertisements by Tuesday, and "Proposal" and "Situations Open" Advertisements by 11 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

The up-to-date picture of conditions on the Panama Canal work which is given in Chief Engineer Stevens' testimony, published in this issue, will be studied with interest, we are sure, by all our readers. Particularly noteworthy are Mr. Stevens' statements regarding the character of material to be taken out of Culebra cut, and sanitary and health conditions and the labor situation. For the information of the general public, which still appears to hold the idea that something or other desperately wrong is to be uncovered at Panama, it is a pity the newspaper press has not given the same prominence to Mr. Stevens' straightforward statement of actual conditions that it has to a dozen ill-founded stories set afloat by irresponsible newspaper writers.

The most valuable and important paper on electric power plant engineering that has appeared for a long time is that by Mr. Henry G. Stott, read at the last meeting of the American Institute of Electrical Engineers and reprinted in this issue. As Mr. Stott has under his personal direction the largest amount of electric generating machinery, probably, of any engineer in the world, he writes with authority, and his summary of the status of existing best practice will doubtless be referred to in years to come as the most authoritative record of engineering practice in this field at the present day.

There is somewhat of a tendency at the present day to consider the steam turbine as the final word in power station design. Mr. Stott shows, however, that so far as heat efficiency is concerned, the highest type of reciprocating engine and the steam turbine are very closely on a par, so much so that he suggests a combination of high pressure steam engines, and low-pressure condensing steam turbines as offering higher economy than either alone.

The great future advance in power station equipment, however, Mr. Stott makes very clear, is to be the use of the internal combustion engine. Whereas the present electric power station sends out as electric current only one-tenth of the energy contained in the coal which it consumes, it is entirely possible that the power station of the near future, using machinery already perfected in the shape of gas producers, engines and steam turbines, will transform more than a quarter of the heat into electric current.

If this prophecy comes true—and it is based on sound engineering facts and principles, it will doubtless compel the rebuilding of many of the great central power stations that have only recently been completed.

In discussing the public land surveys in our issue of Jan. 25 we expressed the opinion that the subdivision of the Public Lands would be done at less cost to the Government and far more efficiently if the work were done by the Government's own engineering force, instead of by the time-honored method of farming it out by contract to local land surveyors.

In support of this opinion, we have much pleasure in presenting in this issue the record of the actual work done by the Government in 1895 in the survey and subdivision of nearly 31,000 square miles of land in the Indian Territory. The article is contributed by the engineer who had direct charge of this work, and is therefore an authoritative record.

It seems almost incredible that private toll road highways once so common in this country, should have been tolerated in any populous community until the present time. But no later than Jan. 19, Mayor Weaver transmitted a message to the Philadelphia Councils, opening as follows:

> It becomes my pleasant duty to inform you that three toll houses on the line of York Road, between Erie Avenue and the County Line, have been closed, and York Road now becomes the property of the city, and with the act of closing the toll gates, the last toll gate within the limits of the County of Philadelphia has been abolished.

Perhaps Philadelphia should not be considered backward for delaying so long in making an important highway free to the public, in view of the neglect which it and most other American cities have shown in granting valuable street railway franchises with little or no provision for compensation or for the protection of the public in other particulars. Few cities have been worse sinners than Philadelphia in this respect, particularly in recent years. In fact, the end of the late shameless political regime in Philadelphia was greatly hastened last summer by one of the most inexcusable surrenders of public streets to private corporations ever recorded in the annals of municipal corruption. This surrender, however, was frustrated by the bold stand of Mayor Weaver, just at that time, on the gas lease extension and on the very street railway ordinances in question. This stand, backed by the public sentiment that it aroused, or rather that it augmented, resulted in the repeal of ordinances which gave to local street railway interests exclusive rights for a half century to come, even though the franchises should not be utilized.

What reforms an aroused municipal citizenship can effect was never better illustrated than by the sequelae of the attempted gas and street railway steals at Philadelphia, and the "ripper" legislation at Harrisburg that shortly preceded those attempts. At the city election in November the local ring was overwhelmingly defeated. The events at Philadelphia and elsewhere in Pennsylvania so impressed the politicians, including the governor, that the latter called a special session of the legislature to enact reform measures demanded in no uncertain terms by an aroused if not enraged public. The first fruits of the legislative session is the repeal of the Philadelphia "ripper" bill by a vote of 182 to 2 in the House and a unanimous vote in the Senate. The bill in question took from the mayor the power of appointing both the director of public works and the director of public safety and vested it in the two branches of the city council. Inasmuch as the mayor is responsible, under the city charter, for the "good order and efficient government of the city," he was, as the "Public Ledger" points out, left helpless to perform his duties. This "ripper" legislation, it should be added, was not made immediately effective, because at the time it was passed it was not known that Mayor Weaver was so soon to turn from the machine to the people. On this account, therefore, the successful demand for the repeal of the "ripper" bill is all the more notable, since by it the future rather than the immediate present is affected. This victory, in its immediate effect, is one of principle, and as such is two fold: (1) Against violent interference with home rule in municipal government, and (2) against a departure from the well-approved principle that in municipal government the legislative and executive functions should be kept separate, which would not be the case if the Philadelphia councils appointed the heads of the police and public works departments. If the people of Philadelphia untiringly persist in their efforts they may still further regain self-government, and they may also, in the future, retain control of many valuable privileges heretofore lavishly granted without compensation to public service corporations.

A 100-ft. weir and weir basin, with automatic recording apparatus, is such an unusual adjunct of a masonry dam that we call attention to the one pictured on the first page of this issue. The dam is located in South Africa and besides the measuring weir and accompanying apparatus to record all the water wasting over the dam there is a Venturi meter and recorder for the supply drawn off to the city of Port Elizabeth. Moreover, in order that "every drop" of the stream flow may be recorded the washout pipe from the bottom of the reservoir discharges into the measuring basin, a provision which hardly seems necessary unless it is expected that a large volume of water will be wasted in this manner. The specific object of these comprehensive stream measurements is to gain information for guidance in providing possible additional storage on the river above the dam just completed. Presumably, stream flow data in South Africa are meager. It is to be hoped that nothing will interfere with the keeping and publication of complete records, as designed, at this dam. A very useful purpose would be served if the overfall of the dam should itself be used as a weir, under varying conditions of head, and the results checked against the special weir measurements.

Although the State of New York was relatively backward in entering upon highway improvements at the joint expense of the State and the localities benefited it has been making up for lost time by the magnitude of its recent action in that respect, crowned a few months ago by the popular approval of a constitutional amendment permitting a $50,000,000 bond issue for State road work. Elsewhere in this issue some account is given of the State highway improvements already made or proposed. The same article contains the encouraging news that 450 New York towns, with 40,000 miles of roads, have changed from the shiftless and wasteful labor system to the money system of road repairs. Mr. Henry Van Alstyne, State Engineer, expresses a determination to secure uniform financial accounts and detailed reports on local road and bridge work. He proposes standard forms of accounts, prepared by his department. He very rightly says:

> These will permit comparisons between the different towns and will also permit any citizen to know just what disposition has been made of money expended for highway purposes.

This sentence deserves the careful consideration of all those responsible for local improvements, either rural or urban.

Complaints of injury to macadamized roads by automobiles are beginning to be heard in many sections of the country. In Chicago, it is stated that some of the boulevards are continually under repair on this account. The surface of the road becomes covered with oval depressions which extend below the top-dressing and into the bed of broken stone, which thus becomes loosened under the traffic, and the size of these depressions rapidly increases. The trouble is aggravated from the fact that the weight of the other vehicles permitted upon the boulevards is not sufficient to re-pack the loosened bed of stone.

In wet weather, these depressions hold water, which softens and disintegrates the road; while in winter the frost penetrates and exercises a still more injurious action. The paving will usually last only about six months before requiring to be resurfaced, and parts of the road where the pav-

ing is 12 months old are in very rough condition. The use of sprinkling compounds is not thought likely to effect much improvement, except temporarily or where the traffic is light. Where the traffic is heavy (in amount rather than in weight) and some permanent improvement is sought for, something with greater "body" is felt to be necessary to hold the stones together and to resist the suction and disintegrating effects of the wheels of automobiles passing over the road at high speed. The use of tar has been suggested for this purpose by Mr. A. N. Johnson, State Highway Engineer of Illinois, who has used this with success on macadam roads made with novaculite in Jackson County, Tennessee. The tar was put on hot, and during hot weather, and was then covered with screenings, well rolled in. Investigation showed that in some places this tar had penetrated 2 ins. into the bed of stone. There is no fear of the surface becoming sticky or soft; on the contrary, it is a question as to how long the tar will last before it loses its life and becomes brittle or friable. The use of tar has been adopted extensively in France, especially since the wide use of automobiles has developed troubles which were not experienced under animal traction. Where automobiles form a considerable portion of the traffic, it is evident that special methods of road construction will have to be adopted in order to provide a surface that will remain in good condition for a reasonable time and at reasonable cost.

CONCERNING NATIONAL REGULATION OF RAILWAY RATES.

The Hepburn bill, empowering the Interstate Commerce Commission to fix railway rates, under certain conditions and limitations, will probably have passed the House of Representatives by the time this issue of Engineering News reaches its readers; and, according to press reports, it is said to stand a good chance of passing the Senate, although doubtless with more or less radical amendments.

We do not intend to present in this place any long discussion of the subject; for we suspect that readers are as weary of it as are the editors who are daily loaded down with the documents poured forth by the diligent railway press bureaus.

We do think it worth while, however, to call attention to a recent utterance on this subject by a well-known railway official, which is so far out of the usual order and contains so much provocative of thought that it is worthy of general attention. We are referring to a speech by Mr. A. B. Stickney, President of the Chicago Great Western Ry., delivered before the Chicago Real Estate Board on Jan. 25. Mr. Stickney's subject was "The Railways and the People," and he is quoted in the press dispatches as follows:

> Railway rates may be likened to a first mortgage on everything that is produced and transported—rates must be paid first, regardless of whether the balance is a profit or a loss to the shipper or the producer. Looking at the monopoly of the railway from this view, it is easy to see how it may become as oppressive as the land monopolies. It is no answer to say that railway rates have not thus far been oppressive. . . .
>
> It is my conclusion that, because the railways have assumed the common law obligations of common carriers, and because they are public highways, and by accepting their charters have subjected their property to a public use, it is fair and right to control their rates by law, and that, because railways are monopolies, the law of self-preservation, as well as fairness and justice, demands that the people, through the Government, should control railway rates by law. Such laws, however, in order to be fair and effective, must be intelligent and directed to the substantial facts, which are the basis of reasonable rates. At present the basis of just and reasonable rates is unknown.
>
> The country is indebted to Theodore Roosevelt, as President, for the courageous course he has taken in regard to legislative control of rates. He has recommended that whenever the reasonableness of any rate is challenged, the legislative commission, after full investigation, shall have the power to determine and put in force a rate which the commission shall deem just and reasonable. And if this principle is incorporated in the bill which shall become the law, it will be an assertion on the part of Congress of its right to fix all railway rates. For this purpose the enactment of such a law will be immensely valuable, because it will be a precedent in future legislation when the whole problem shall come intelligently before Congress in the final contest which will sooner or later come. As a precedent it is worth enacting.
>
> Otherwise than a precedent, I do not regard it as of any value whatever. It cannot in the slightest degree affect the rebates. Further, when we reflect that it requires over two billions of separate rates to make a schedule upon one commodity between all the railroad stations of the United States, and that there are six classes and as many more separate commodities, requiring, say, twenty-four billion rates to make a complete tariff, and that under the proposed law the commission can consider only one at a time, and that the commission might possibly investigate and decide three or four rates a year if the railroads did not make too determined a resistance, it is easy to see that it will take a commission a great many years!
>
> A bare statement of the facts proves that a more comprehensive plan must be used. The only possible way of accomplishing such a task is by discovering the general principles of reasonable rates, and, based on such principles, the actual rates can be ground out by thousands of operations by mathematical machinery, making, so to speak, thousands of revolutions a minute.

Mr. Stickney has become well known as a railway president who does his own original thinking. In the face of his clear-cut statement, all the literature which the railway press agents have spread abroad respecting the proposed legislation as a threat against the railways' solvency appears silly indeed.

Of course, Mr. Stickney purposely exaggerates in his portrayal of the Commission as physically incapable of really establishing general control over railway rates. As a matter of fact, the enactment of the Hepburn rate bill will probably have a beneficial effect in making railways more careful not to establish excessive rates; and, further, the fixing by the Commission of a single rate on an important commodity handled on routes of heavy traffic—say, for example, grain from Chicago to the seaboard—may affect the revenue on a very large volume of business.

We are in full agreement with Mr. Stickney, however, that the proposed railway rate legislation in its present form is to be regarded as only an entering wedge, and not by any means a permanent solution of the problem of equitably regulating the relations between the railways and the public.

Nor shall we have a permanent solution, as Mr. Stickney says, short of the formal establishment by some governmental body of some standard as to what constitutes a "reasonable" rate. The Hepburn bill copies the present Interstate Commerce Act with the high-sounding declaration that "all charges * * * shall be just and reasonable." It leaves with the Commission, however, the entire responsibility of determining what constitutes "reasonableness" in a railway rate; and under the law the Commission can do no more than take up each separate rate as it is brought before it in a formal action and determine—or pretend to determine—whether that particular rate is "reasonable" or not.

Mr. Stickney is entirely correct in saying that the large question of governmental control over railway rates cannot be permanently settled by any such piecemeal treatment. If we take the time necessary for the Interstate Commerce Commission to hold a judicial investigation and consider the expense to the Government and the expense to the complainants and the railways for counsel fees, etc., it is readily seen that the actual expense of establishing a rate through this complicated machinery, even when no further appeal to the courts is made, will mount up into thousands of dollars, or in most cases a far larger sum than the entire amount in controversy between the railway and the shipper. This would not be objectionable if by such decisions there was built up a body of general principles to govern railway officials in making rates; but very little has been accomplished in this direction. With the exception of the much-maligned "long and short haul" clause of the original Interstate Commerce law, and the extension of the classification system of grading freight for rate-making purposes, we may say that nothing has been done by either the railways or the Government toward the settlement of the question, "What is a reasonable railway rate?"

It should be said, in passing, that even the most rabid defenders of the railways' right to their rates without governmental interference admit that, of course, all rates must be "reasonable." Having made this admission, however, we will search in vain for any definition of what they regard as "reasonable," or what point they would fix at which the railways' charges would cease to be "reasonable" and become exorbitant. Usually, what they advocate, although they carefully refrain from stating it in so many words, is that the railway traffic manager shall be the court of last resort as to whether a rate is "reasonable" or not. But it is exactly this condition and the abuses which have existed under it that has aroused a public protest that is now crystallizing in the form of national legislation.

Inadequate as that legislation is certain to be, it is nevertheless a step in advance, and one which must inevitably lead at a later day to action on the larger question of the principles that should govern rate making. It is to be remembered that it is not alone the relations of the railways and the public that hangs on a settlement of this question. There is also involved the relations of competing shippers, of the independent industries struggling for life against trust rivals, of competing shipping ports and commercial centers, and, finally, and not least, of the rights of the railway stockholder, whose right to have his property earn a reasonable income on his investment needs to be established on a sound and legalized basis.

LETTERS TO THE EDITOR.

Marking Preliminary Survey Stakes.

Sir: I notice in your issue of Jan. 11 a communication from T. G. Kitchin, which you have headed "A New Method of Setting and Marking Preliminary Survey Stakes."

This reminded me very forcibly of the first stake I ever marked for which I received pay. I used this new method (i. e., lettering from point towards the end of stake). The present Chief Engineer of the Northern Pacific noticed the same; I do not recollect his exact words, but as you can imagine, they were forcible. I have never marked a stake in that manner since.

I may state, however, regarding the permanency of marks, that I have found stakes on the prairie on which the figures could be made out, which had been marked ten years previously. They were marked with keel (red hematite).

Yours truly,

J. G. Sullivan.

Culebra, Canal Zone, Jan. 22, 1906.

(The principal novelty in Mr. Kitchin's method was the use of large, flat stakes, 6 ins. wide at fence intersections, as auxiliaries to the regular station stakes.—Ed.)

Concerning Burned Rivets.

Sir: In reference to the subject of overheated and burned rivets which, although it started from a small beginning, has developed into a very complete and instructive discussion, I quite agree with Mr. Godfrey in his statement that a very large proportion of rivets are inspected, after driving, to discover those defective from burning and other causes. It often happens that rivets are inspected several days after being driven. It is therefore necessary, in such cases, to determine burned rivets almost wholly from the external appearance of the heads; pits, rough surfaces, cracks and a reddish color instead of a bluish steely color are generally considered as indications of overheating and burning. None of these conditions can be absolutely relied upon as a test.

It has already been pointed out that an accumulation of steel scale in the cup of the dollie will produce an appearance similar to that of pitting due to burning the metal. There is also another condition which sometimes produces a pitted effect upon the field head of rivets. Where pneumatic hammers are used the riveters sometimes make use of the hammers to remove drift pins and "fitting up" bolts from the holes. This misuse of the hammer produces indentations in the cup of the hammer which, in some cases, will produce an effect upon the head of a rivet similar to pitting.

When a piece of steel is heated a chemical action of decarbonizing and oxidizing takes place. This action starts upon the surface and works inward. The depth of the effect depends wholly upon time and temperature. Because of this action rivets should not be reheated several times, neither should they be allowed to remain too long in the forge.

Where possible an inspector should note the condition of the rivets as they come from the forge. Rivets that

"spit" as they come from the forge should at all times be regarded with suspicion. It is a fact that nearly all burned rivets are due to carelessness on the part of the "heater." He leaves his forge for a short interval and returning finds his rivets overheated. Failing to keep a proper lookout for the progress of the riveters he finds his forge full of hot rivets at a time when several minutes are required for shifting or erecting scaffolding. This accounts for the fact that an inspector occasionally finds several burned rivets close together, possibly all in the same connection. When an inspector finds several suspicious rivets in close proximity it is wise for him to order a few of them, perhaps two or three, cut out, always picking the worst ones for this purpose. If those cut out do not yield freely to the action of the "buster," if the fracture is bluish-gray, even-grained and silky in appearance, then it is reasonable to assume that the conditions which he has taken as indicating burned rivets are misleading. When the whole structure is considered it must be admitted that the cutting out of an imperfect rivet will sometimes do more injury through overstressing the material around the hole than if it had been allowed to remain intact. Of this condition the inspector must be the judge.

The injury to the material may be reduced to a minimum by placing a dollie against one head and cutting away the flange of the opposite head, with a cutter, sufficiently to allow the removal of the rivet, from the hole, by the use of a "backout."

L. N. Edwards,
Assistant Engineer, Boston & Maine R. R.

Boston, Mass., Jan. 22, 1906.

Locating Soundings in Shallow Water with the Aid of a Cable.

Sir: On page 69 of your issue for Jan. 18, 1906, T. W. C. "requests information as to experience in locating soundings in shallow water with the aid of a cable" 500 ft. to 1,500 ft. long.

The best kind of a cable for such work is a flexible wire cord, with a hemp center, the so-called signal cord. For a cable 500 ft. long I would recommend the 1/16-in. diameter, and for lengths of 1,000 ft. and over, the 1/8-in. diameter. [See letter following this—Ed.] The best method of tagging the cable is by means of brass tags 3/4-in. in diameter, having a small hole punched near the circumference. These tags are numbered on both sides with the numerals 1, 2, 3, 4, 5, etc., indicating 10, 20, 30, 40, 50 ft., etc.

To graduate the cable it is best to have a level floor a little over a 100 ft. long. A board walk, wooden pier or other suitable structure will answer as well.

Holes of 3/4-in. diameter are bored at 20-ft. intervals, into which iron bolts of the same diameter are driven. To start with, it is best to splice a suitable eyelet at the end of the cable, to which any appropriate arrangement for holding or fastening the same can be attached. The cable is then stretched and laid alongside of the bolts previously driven, and, beginning at the first bolt, a small wire is passed a number of times around the cable, the correct brass tag is then strung in the wire, the latter passed around the bolts, and then wound around the cable a number of times and cut off. This procedure forms the loop. This is continued to the end, checking up each 100 ft. with a steel tape.

To keep the cable from sinking, wooden floats are used. These are made of the lightest wood procurable. Kiln dried pine is good. They are round cylinders, 3 ins. in diameter, 5 ins. long, slightly rounded ends and a turned groove in the middle. Ordinary harness snaps are attached to the floats by heavy fish line, passing through the eye of the snaps and resting in the groove. The floats are painted white for the 20, 40, 60 and 80-ft. ones, and red for the 100-ft. ones. It is generally sufficiently close to graduate the 1,000-ft. cables every 20 ft., while the 500-ft. cables can be graduated every 10 ft.

In this connection it will be well to guard against the use of plain wire, which is likely to kink at the slightest provocation, and also to snarl badly. The wire cord spoken above does not do this.

When not in use the cable is wound up on a reel. When using, after the end of the cable is attached to the shore, the reel is placed in the stern of a rowboat and the cable slowly paid out, the floats being attached at the same time. This is readily done, the harness snaps being snapped into the loops as they go overboard.

The reel is an inexpensive contrivance and can be made readily by a carpenter, or any one possessing a little mechanical ability.

In a heavy wind or a current there is some difficulty to keep the cable taut, this on account of the floats being carried along. A very heavy strain would, of course, break the cable, and in situations of this kind the only remedy is to use a heavier cable, say, 5/16-in. diameter. A little experimenting will soon develop the proper size to use.

Yours truly, Emile Low.
M. Am. Soc. C. E.

132 Lancaster Ave., Buffalo, N. Y.

Sir: At the request of Mr. Emile Low, we beg to inform you that the 1/16 and the 1/8-in. diameter wire cable, which we have furnished him at various times, is known as galvanized signal cord. In construction it is formed of six strands, laid about a cotton center, each strand being composed of seven wires. The list price of the 1/16-in. is 1¾ cts. per ft., and the 1/8-in. is 2¼ cts. per ft. The discount is 37½ and 2½%. The Roebling Co., of New York City, is a manufacturer of this cable.

Yours truly,
Howard H. Baker & Co.,
Ship Chandlers.

Buffalo, N. Y., Jan. 26, 1906.

A Diagram for Computing the Flow of Water Over Weirs.

Sir: The following diagram, worked out by the writer, may prove of interest to your readers, and especially to those who have to deal with weir measurements of water. To calculate the discharge for each measurement by the formula is slow and tedious; tables are voluminous and often inconvenient. The following gives a simple method of constructing a diagram from which the discharge can be read directly.

As the construction of the diagram is exceedingly simple it can be quickly made to any desired scale and for any desired range of readings. The diagram is based on the Cippoletti formula:

$$Q = 3.367\ L\ H^{3/2}$$

where Q=discharge in cu. ft. per sec.; L=length of weir in ft.; and H=head in ft. Expressing this in logarithmic form we have,

$$\log Q = \log 3.367 + \log L + \tfrac{3}{2} \log H, \text{ or}$$

$$\log Q = C + \log L + \tfrac{3}{2} \log H, \text{ where } C = 0.52724.$$

From an inspection of this equation it is evident that if we plot two equal parallel scales, one for Q and the other for H, a third scale must be determined for L. Also, the horizontal distance between the scales must have the ratio, 3:2, or, the scale of L must be placed three times as far from the scale of Q as the scale of H.

The determination of the vertical position of scale H and the size of scale L is equally simple and as follows:

Suppose that the lengths of weirs for which we desire to make the diagram range from 1 to 10 ft. For such weirs, 0.1 sec. ft. is perhaps the lowest reading likely ever to be made, and 500 sec. ft. the highest. Beginning with 0.1 we plot the logarithmic scale for Q on the left hand side of the sheet. We then choose a convenient distance between scales Q and L. For ordinary field diagram 4 to 6 ins. will be found satisfactory. Draw the line for L parallel to Q, its lower end on a perpendicular from the lower end of scale Q. Mark this point 10 ft. Determine vertical position of scale H as follows:

$\log Q = C + \log L + \tfrac{3}{2} \log H$. Substitute above values.

$1 = 0.52724 + 1.000 + \tfrac{3}{2} \log H.$

$H = 0.02066.$

Take 1/3 of the distance from Q to L and draw a line parallel to Q for scale H. The intersections of H with a straight line connecting the lower extremities of Q and L is then 0.02066, and H can be plotted, being equal to scale of Q.

To complete the diagram it now remains to determine another point on L so as to fix the size of the scale.

Again $\log Q = c + \log L + \tfrac{3}{2} \log H.$

Let Q=10 sec. ft.; then H=2.066, since scale Q and H are equal,

and $1.000 = 0.52724 + \log L + \tfrac{3}{2} \times 0.31513.$

L=1, or 1 on L, is horizontally opposite 10 on Q.

Divide L logarithmically from 1 to 10 and the diagram is complete. For convenience in plotting it may be well to note that scale L is exactly twice the size of scale Q or H.

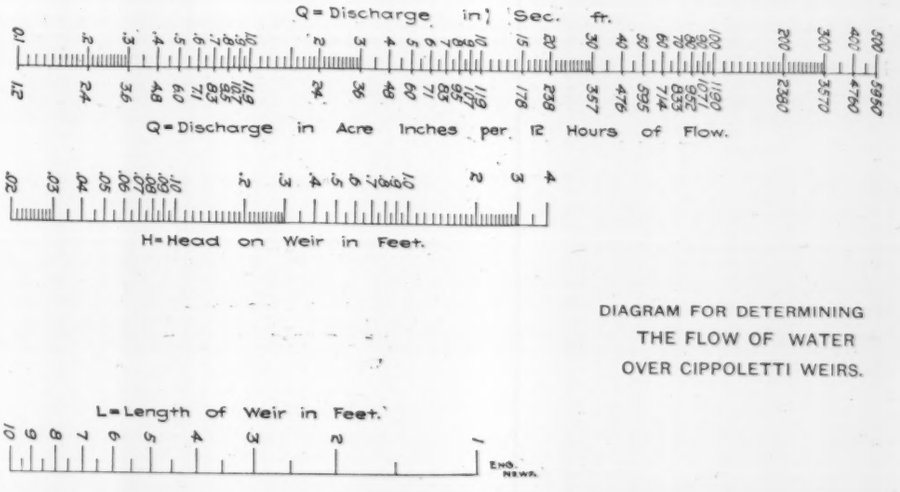
Q = Discharge in Cu. Sec. ft.
Q = Discharge in Acre Inches per 12 Hours of Flow.
H = Head on Weir in Feet.
L = Length of Weir in Feet.
ENG. NEWS.

DIAGRAM FOR DETERMINING THE FLOW OF WATER OVER CIPPOLETTI WEIRS.

To read the discharge, having given length of weir and head, place a straight edge on corresponding points on L and H. Where the straight edge intersects Q read discharge direct. Example: Given a 5-ft. weir with a head of 0.2 ft., find discharge. Placing straight edge at 5 on L and 0.2 on H we find it intersects Q at 1.506. Discharge=1.506 sec. ft.

On the other side of Q the divisions can be made for the discharge in gallons for any given unit of time, miners inches, acre inches in a given time, or in fact any unit which is desired, thus furnishing also a convenient conversion table from one unit to another. In the accompanying diagram the conversion is to acre inches per 12 hours of flow, which is very convenient for irrigators.

Yours truly, Andrew P. Anderson.

State College of Washington, Pullman, Wash.,
Jan. 1, 1906.

The Value to an Engineer of Ingenuity in Meeting Emergencies.

Sir: I have often thought that a very valuable asset to any engineer in the active practice of his profession, and, for that matter, for any one, is resource in times of emergency. That man who can turn the forces that seem tending to his certain defeat, or that appear to be negativing the accomplishment of a desired result, is the man who is sought by those who have the administration of the things that are really great, and is the best friend to himself.

If I mistake not, the word "engineer" and ingenuity have the same common derivation. Ingenuity implies that alertness of mind, that grasp of situations, that knowledge of the natural forces of nature, that marks the Edison, the Bell, the Herschel, the Francis, who have already added their imperishable quota to the world's knowledge, and of the many men in different branches of the world's service who are now adding, though unheralded, to the great total.

Every issue of Engineering News is a chronicle of some victory achieved, some new scheme outlined, some new thought promulgated, that is evidence of this. Whether it be the account of the novel construction of a dam upreared in air, or the improved sharpening of a stake, the idea is the same.

These thoughts were occasioned the other evening upon hearing Hon. Edward D. Adams, who was president of the company that first made a success in commercially utilizing Niagara's power, tell of the incidents and accidents that made the history, or part of it, of that undertaking:

After the line for the tunnel had been marked upon the ground, this work having been done when there was no obstruction by reason of foliage, it later became necessary to rerun the lines for the purpose of a check. The observation towers were mounted and the instruments were positioned and adjusted, when it was found that at just one point there was an impassable obstacle, in the shape of a large tree, in full leaf, through which the line passed, and which was effectual in stopping the work. An effort was made to get the owner of the tree to remove it; but he would not sell it, nor even trim it, or permit others to do so. It looked as if expensive and tedious detours, objectionable because of the liability to error, would be necessary. At this point one of the younger engineers in the party said that he believed he could get around the difficulty if he were allowed a little time and authority to proceed. This was granted, and for a week or so he seemed to be quite unconcerned about the matter, much more so indeed, than others over him. At the end of the time, however, he took the engineers up to the tower, and there before them was a clear view in the desired direction, the tree being outlined by bare branches. Pressed for the reason, the young engineer did not at once tell his secret; later it came out. At the time of the trouble he had noticed that the tree was a bass-wood;

in his college days while interested in botany, he had noticed that the bass-wood was the prey of a certain insect which sometimes denuded it. He had searched until he had found a particularly well infected tree, and then, gathering a hatful of the parasites, he had carefully planted them after dark on the tree in question. The result was satisfactory so far as results were concerned.

The method employed by the young man is not to be commended.

I have the honor of the acquaintance of an engineer, resident in a pretty New Hampshire village, who was the first man to utilize the lifting power of water in erecting standpipes. The standpipe was being put in a town of Georgia, I think, and the difficulty and expense of erecting staging for the workmen were almost prohibitory. Thinking the matter over, the thought struck the engineer that he could construct a floating platform and have men and staging lifted to the top by pumping in water as the work progressed. The scheme was put into operation successfully, and has since been used in other like conditions.

A firm of mechanical engineers had for some time been searching for an effective way to apply the pressure of steam to a column of cold water. It was desired, if possible, to transmit the pressure directly to the water, and many ideas and devices were tried, unsuccessfully, to prevent the water from condensing the steam. Thinking the matter over after some more brilliant failure, possibly, than the last, the idea popped into the head of one man that steam was lighter than air, and air was a non-conductor, so he would try the effect of an air cushion between the two. The plan worked, and is to-day a useful mechanical device in service in many factories and shops throughout the country.

Ingenuity, or the same thing spelled in another way, perseverance in attaining an object, is a valuable asset of an engineer. F. M. G.

New York, Jan. 20, 1906.

(As to the tree incident, we agree with our correspondent that the method employed by the young man is not to be commended; we would go further and say that it was a low-down, parasitic trick.—Ed.)

A Method of Solving Right Triangles of Flat Slope.

Sir: Most computations in structural steel work are made to the nearest sixteenth of an inch. The following table will enable one who is not the possessor of a book of squares to readily determine, for small slopes, the hypothenuse of a right triangle, knowing the length of the base and the slope of the hypothenuse in inches per foot. This method is practical for low slopes only, as it is found that for higher slopes the value of x decreases so that an error of 1/16-in. or more will be found unless x is calculated to a long decimal, which is not practical for division. For the slopes in the table, 1/16-in. to 2 ins. per foot, the method will be found to be of sufficient accuracy.

The method is as follows:

SLOPE LENGTHS FOR FLAT SLOPES.

For Each "x" Contained in Length Add 1/16-in. for Slope Length.

Slope.	Angle. deg.	mins.	secs.	x ft.	ins.
1/16-in. to 12-in.	0	17	54	384	0
1/8	0	35	48	96	0
3/16	0	53	42	42	8
1/4	1	11	36	24	0
5/16-in. to 12-in.	1	29	29	15	4 1/4
3/8	1	47	22	10	8
7/16	2	5	15	7	10
1/2	2	23	7	6	0
9/16-in. to 12-in.	2	40	59	4	9
5/8	2	58	50	3	10
11/16	3	16	41	3	2
3/4	3	34	31	2	8
13/16-in. to 12-in.	3	52	21	2	3 1/4
7/8	4	10	10	1	11 1/2
15/16	4	27	59	1	8 1/2
1	4	45	47	1	6
1 1/16-in. to 12-in.	5	3	34	1	4
1 1/8	5	21	20	1	2 1/4
1 3/16	5	39	5	1	0 3/4
1 1/4	5	56	48	0	11 1/2
1 5/16-in. to 12-in.	6	14	30	0	10 1/2
1 3/8	6	32	11	0	9 1/2
1 7/16	6	49	51	0	8 3/4
1 1/2	7	7	30	0	8
1 9/16-in. to 12-in.	7	25	7	0	7 3/4
1 5/8	7	42	43	0	6 13/16
1 11/16	8	0	17	0	6 9/16
1 3/4	8	17	50	0	5 7/8
1 13/16-in. to 12-in.	8	35	21	0	5 7/16
1 7/8	8	52	51	0	5 1/16
1 15/16	9	10	18	0	4 13/16
2	9	27	44	0	4 1/16

In a right triangle let x, the base, be of such a length that the hypothenuse equals x + 1/16-in. Calling the angle of slope α, and expressing x in feet, we have

$$\cos \alpha = \frac{x}{x + .0052083 \text{ ft.}}$$

$$x = \frac{.0052083 \cos \alpha}{1 - \cos \alpha} = \frac{.0052083}{\sec \alpha - 1}$$

This value of x was determined for different slopes, varying from 1/16-in. per ft. to 2 ins. per ft., and is given in the table herewith. It will be seen that as many times as x is contained in any given base, so many sixteenths of an inch will be added to the base to determine the hypothenuse.

Example: Base = 28 ft. 4½ ins.; slope, ½-in. per ft. From table, x = 6 ft. 0 ins.

$$\frac{28{,}375}{6} = 4{,}729.$$

Therefore the nearest sixteenths would be 5, and the hypothenuse would be 28 ft. 4½ + 5/16 ins. = 28 ft. 4 13/16 ins.

Chas. T. Lewis.

Link Belt Machinery Co., Chicago, Ill., Jan. 15, 1906.

(Some other methods for computing the hypothenuse of a right triangle have been given in our pages previously; see 1891, II., 289; 1902, I., 52, 113, 154. The assumed data for the problem to which such methods are applied are, usually, horizontal run and vertical rise, and the purpose of the methods is to get around the need for calculating squares and extracting square roots, a roundabout task when feet, inches and fractions of inches are involved. Probably the most convenient method for desk work is one given by J. A. Ray, 1902, I., 52, which employs a diagram whose abscissas are horizontal distance and whose ordinates are vertical rise; the diagram gives, in inches and fractions, the quantity to be added to the horizontal run to obtain the hypothenuse. The method above presented by Mr. Lewis employs slightly different data; instead of total rise the slope is given, in terms of inches per foot, as it is usually stated in roof-work. The diagram method of Mr. Ray can, however, easily be modified to enable the same data—base and slope—to be used, by simply drawing slope lines on the diagram. The diagram would seem to be appreciably more rapid and convenient than the table here shown, but the latter is a trifle more compact.—Ed.)

Concerning Wide Tires and Road Improvement.

Sir: You said in your issue of July 4, 1901, in comment on my letter published in that issue, "Wide tires are all right for earth roads, and to some extent for macadam roads." I now ask you to reconsider your reservation as to "improved" roads. Narrow tires are all wrong for any road or street. Here is the proof, even that improved wheels on unimproved, or less improved, roads are rather to be chosen than "improved" roads under present wheels. "Bad" roads made or rather kept wide-tire-good, are shown, by the following Missouri Experiment Station "tests" (all unfair as they were to wide tires), to give better draft conditions than do "improved" roads made narrow-wheel-bad.

Tractive Force in Pounds Required to Haul a Wagon Weighing 1,500 lbs., Carrying a Load of 2,000 lbs.

	Width of tire. 6 ins.	1½ ins.
Dirt road, dry, hard, free from ruts or dust	146 lbs.	178 lbs.
Macadam street, hard, smooth, nearly free from dust, loose stones or sand	123	143
Dirt road, dry, hard, free from ruts and dust	104	141
Macadam street (same as above)	73	99
Clay road, dry, hard, ruts almost obliterated, surface worn smooth	71	130
Gravel road, dry, hard and free from dust, few loose stones	92	125
Average pull on 3 unimproved roads under improved wheels vs. 3 improved roads under present wheels	107 vs.	124
Average pull in 3 cases of improved roads and wheels and 3 unimproved roads under present wheels	96 vs.	150

Don't forget that all of these surfaces are "narrow-tire-bad" (since narrow tires are in general use), which is proper for the 1½-in. wheel test but not for the 6-in. wheel test. A proper test of the 6-in. tires would show about this:

	6-in. lbs.	1½-in. lbs.
(Wide, freed from narrow tire effects)	75	124
Average of the 6 pulls (corrected)	50	150

So that instead of what we now have:

$$\frac{1\frac{1}{2}\text{-in. tire}}{150 \text{ lbs.}} \quad \frac{1\frac{1}{2}\text{-in. tire}}{124 \text{ lbs.}}$$

we should have, at most,

$$\frac{\text{6-in. tire}}{75 \text{ lbs.}} \quad \frac{\text{6-in. tire}}{50 \text{ lbs.}}$$

Notice that reduction of pull to, say, 75 lbs. by use of wide wheels does not cost anything—costs less than nothing—since the wheels come to much more than they cost, by saving wear to themselves and their v... Compare this with the cost of the usual kind of "improvement" and reduction, practically increase, ... to 124 lbs. The natural philosophy of the wheel ... indicate a greater difference even than this. As co... with the 6-in. tire, the 1½-in. or one-quarter ... wheel gives something between a four-fold crushing ... sure and a 16-fold on hard, to 31-fold depth of ... soft roads. The degree of each in the combinati... be found by actual test. Fortunately the only ... wide wheel tests made by the Missouri Experiment ... tion (on agricultural land, one trip enough) show ... thing on this head.

	Width of tires. 6-in.	1½-in.	6-in.
Timothy sod, soft and spongy, depth of ruts ..... 1½ to 2 ins.	5 to 6 ins.	= 100%	
First trip each, separate tracks, pull...	324 lbs.	596 lbs.	= 100%

This shows 84% greater crushing pull and three ... the depth of cut.

	Width of tires. 6-in.	1½-in.	6-in.
Same sod and tracks, 12th trip, ruts	4 to 5 ins.	12 to 15 ins.	= 100%
Cumulative, 12th trip, pull	398 lbs.	876 lbs.	= 100%

This shows 120% greater pressure and three times ... depth of cut.

	Width of tires. 6-in.	1½-in.	6-in.
Bluegrass sod, soft:			
Ruts	1-in.	3-in.	= 100%
Pull	231 lbs.	437 lbs.	= 100%
Corn stubble, about ready to plow:			
Ruts	1.5 ins.	5.6 ins.	= 100%
Pull	510 lbs.	878 lbs.	= 100%

	Width of tires. 4 & 5 ins.	2 ins.	4 & 5 ins.	2 ins.
Atlanta test, last trip, depth	0	several inches	= 100%	1,000%
Thoroughly wet clay road, wide tires non-tracking; cumulative last trip, pull	....	....	= 100%	200%

	Width of tires. 4, 5 & 6 ins.	(?)	4, 5 & 6 ins. abated
New York test, macadam	rough		
Condition	smooth & rutty	= 100%	?

Only 3 wide non-tracking wheel wagons, vs. very many ordinary.

Cumulative effect on cost of hauling on macadam.		100%	135%

Narrow tires in this age look to me like "conservatism" gone mad from extreme radicalism. I know of no more radical departure from commonsense than is traffic kept narrow-wheel-"heavy" from superstitious "conservatism." I know of nothing more remarkable than the general feeling, theory, superstition, among engineers, that, while narrow tires are wearing out hard (macadam) roads much more rapidly, horses are doing less work. If destruction isn't, in effect, pull, and more wear of road, and wheel isn't more pull, and doesn't entail still more pull, dog my sheep if I know what it is. If you find out, do not fail to let me know.

J. M. Heiskell.

1107 South Cooper Ave., Memphis, Tenn., Jan. 9, 1906.

(We have not the slightest grudge against wide tires; on the contrary, we are in general agreement with our correspondent, even if we do not take so extreme a position. As of interest in this connection we reprint below an extract from a report of Capt. H. M. Chittenden, U. S. A. (in the "Report of the Chief of Engineers" for 1903), on the Government roads of the Yellowstone Park.

Concerning the table of allowable loads per inch width of tire, given by Captain Chittenden below, we may refer to the editorial discussion in our issue of April 20, 1905, p. 418, where the influence of the diameter of the wheel on the allowable load was considered. We there assumed 4 to 10 lbs. per inch of diameter and inch of width as proper practice for wheels rolling on dirt roads. For such roads as those in the Park, 8 lbs. would probably be a fair figure for the summer months after the roads are dried. For a wheel of 56 ins. diameter this would give an allowable load of 448 lbs. per inch width of tire, which agrees very well with the figures given by Captain Chittenden.—Ed.)

WIDE TIRES.—As a means of maintaining the roads in good condition, a regulation has recently been secured requiring the use of wide tires in all heavy freight hauling. The advantages of wide tires are thoroughly established, but there has been a deep-set local prejudice in the country around the park to their adoption. This arose mainly from the desire to avoid the cost of change of equipment, but to some extent also from a belief that they would draw harder than narrow tires. Arguments of various sorts were used to oppose the change, nearly all of them fallacious and easily disproved, but still sufficient to convince an unwilling public. However, the regulation has practically gone into force, and the result has been a general conviction on the part of every one of

its great advantage, and the prejudice against it will probably disappear in a short time.

It would be difficult to name any one regulation relating to travel upon the roads which is of more importance than that of the use of wide tires in the hauling of heavy freight. There are only two conditions of the roads in which they are at a disadvantage as compared with narrow tires. Where roads have been barely opened and are in a condition of mere wagon trails, and are full of stones and roots, a narrow tire has the advantage because its smaller width avoids to a greater extent the roots and stones and picks its way more easily along the surface of the ground. Again, in the winter season when there is ice on the ground, the wide tire naturally has a weaker hold than a narrow tire in descending steep grades.

The wide tire gives an easier draft in all conditions of well graded roads except one. Where mud is so soft or sand so deep and fine that either will run over the felloe if it sinks deep enough more material will naturally cling to a wide tire than to a narrow one. In thick mud or bog or heavy sand or on turf the wide tire gives the lighter draft. On a pavement or thoroughly hard road surface there is no appreciable difference between the two.

But while the advantage of draft is on the side of the wide tire, the great argument in its favor is its effect upon the roads. That it saves them as compared with the narrow tire, whatever the condition of the road, there is no question. Even in dusty weather they compact the surface and lessen the annoyance from this source. Bicyclists have assured the writer that they have been of very great advantage to wheeling by reason of their effect as road rollers.

Table Showing Reasonable Limit of Loads for Different Widths of Tire and Loads Actually Hauled.

Assume as allowable weight to July 1, 450 lbs. per in. width of tire.

Assume as allowable weight after July 1, 550 lbs. per in. width of tire.

Width of tire.	Allowable loads including weight of wagon, lbs. Before July 1.	After July 1.	Actual loads.	lbs.
1-in.....	1,800	2,200	Light single rig.....	750
1½-in.....	2,700	3,300	Surrey	1,200
2-in.....	3,600	4,400	Coach (small)	4,100
			Freight	12,000
2½-in.....	4,500	5,500	Coach, 6-horse	8,750
3-in.....	5,400	6,600	None in use.	
4-in.....	7,200	8,800	Freight	12,000
5-in.....	9,000	11,000	None in use.	
6-in.....	10,800	13,200	Sprinklers (750 gals.).	10,370

Notes and Queries.

We are informed by Mr. Quint E. Smith, of Concord, N. C., that the correspondent who inquired for information on current wheels may find it in Bulletin 146, U. S. Department of Agriculture.

C. W. T. writes:

Do you consider it necessary to calk cast-iron culvert pipe with hemp or oakum and lead? If so, why and what are the advantages to be gained? Do you consider it important enough to hold up rush work two or four weeks awaiting arrival of material?

If a culvert were so located as to be filled with water under pressure—as almost never happens—there might be some reason for requiring culvert pipe joints to be made tight. Otherwise the only reason we can imagine for calking the joints would be the fear that water might have a tendency to work through the joints along the pipe and gradually undermine it. If the engineer is really worried about this we should suggest a few shovels of concrete around the joint, as quite sufficient precaution. Certainly it would savor more largely of commonsense to do this than to hold up the work for lack of lead and oakum.

A LOW-RESISTANCE THERMO-ELECTRIC PYROMETER.

At the monthly meeting of the American Society of Mechanical Engineers, held at the Society House, New York City, Jan. 30, Prof. Wm. H. Bristol, of Stevens Institute of Technology read a very interesting paper on the above-named subject. Prof. Bristol has devoted considerable time to the perfection of a high temperature indicating instrument which would be inexpensive, accurate, simple, and easily adaptable to all the different uses where such an instrument may be required. All thermo-electric pyrometers in use up to the present time, are of the high-resistance type, using rare metals for the couple, which require a high degree of uniformity of material. The result is a very delicate and expensive instrument, which is easily injured, if subjected to the rough usage of common shop practice. Prof. Bristol's instrument makes use of a comparatively low-resistance indicating instrument, and alloys of some of the common metals in the construction of the couple. Alloys of tungsten, steel, nickel, iron and copper are used, varying in composition according to the maximum temperature, and the indicator used. The entire apparatus consists of three parts—the couple, the leads and the indicator. The couple is made in two sections, fastened by a screw connection. By this means, one indicator and set of leads will serve for any number of couples, which may be permanently left in place, and an injured couple can be replaced at a low cost. The two sides of the circuit are insulated from each other by winding

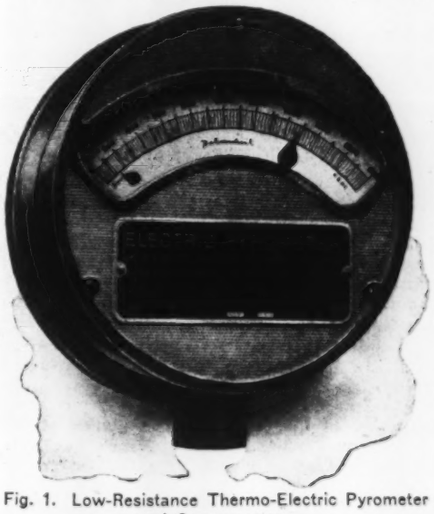

Fig. 1. Low-Resistance Thermo-Electric Pyrometer and Compensator.
(Invented by Prof. Wm. H. Bristol, M. Am. Soc. M. E., of Stevens Institute of Technology.)

each with an asbestos cord and applying a coating of carborundum paint. When the couple is used for determining the temperature of molten metal, without the protection of an iron pipe casing which is sometimes used, there need not necessarily be a physical connection, at the hot joint as the molten metal will act as a conductor. In all other cases the joint is formed by twisting and electrically welding the end of the two alloys together.

One of the great disadvantages in most thermo-electric pyrometers, is the difficulty met with in maintaining a constant temperature at the cold end of the couple and the consequent liability of error in the temperature readings. Prof. Bristol has overcome these difficulties by inventing a very ingenious and simple device, which compensates for any variation in the temperature of the cold end by automatically varying the resistance of the circuit. The compensator, as shown in Fig. 1, consists of a small glass bulb having two wires fused into the top and connected on the

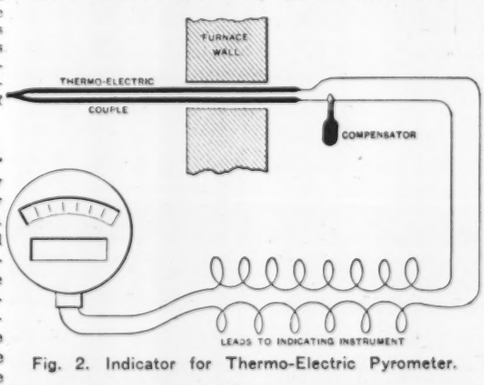

Fig. 2. Indicator for Thermo-Electric Pyrometer.

inside by a loop of platinum wire, suspended in the mercury with which the bulb is partially filled. This is connected in series with one side of the circuit and at the cold end of the couple. An increase in the temperature of this end will cause an expansion of the mercury, short circuiting more of the platinum loop, with a consequent decrease in the resistance of the circuit.

The indicator used is a specially designed instrument made by the Weston Electrical Instrument Co., with scales of different ranges. Among the several styles in use are the vertical dial switchboard instrument, Fig. 2, and a portable instrument arranged in a convenient case. By the substitution of different fixed resistances, any one instrument may be used to indicate a wide range of temperatures.

The low first cost and that of maintenance, together with its accuracy and adaptability in all the mechanic arts, makes it seem probable that this instrument will come into extended use. It has already been adopted in a considerable number of manufacturing establishments.

EXPERIENCE IN CREOSOTING DOUGLAS FIR.*

By P. F. Dundon.†

Our experience, which covers a period of about ten years, has been confined almost entirely to the creosoting of Douglas fir, or as it is more commonly termed in this locality Oregon pine, and from all we can learn it is far more difficult to successfully treat this than either of the species of southern pine. Where submerged in salt water on this coast, piles of this timber in their natural state in some localities are destroyed in one year or thereabouts, but two to three years is the average time in clear salt water.

We have had about 14 years' experience with this same class of piles, creosoted, and they still remain sound. Where creosoted piles have been used for wharf structures, we have found many failures among them, but be due to their being handled or damaged by the workmen so as to allow the toredo and limnoria to gain access to the untreated heart wood. In consequence of the density of this class of timber, it is difficult to obtain a deep penetration, and the penetration is irregular, sometimes varying in the same pile from ½-in. to 2 ins. at different parts of its circumference.

In creosoting Oregon pine the steam vacuum process commonly used is quite destructive to the strength of the timber. It would seem that the fibers lose their cohesion and in consequence the timber becomes very badly checked, and loss of elasticity and strength follows. Where fir piles are treated in this manner the blow of the hammer causes serious checking from end to end; and where this occurs it is clear that a place is made for the teredo to enter the heart wood.

Other serious objections to this class of treatment for Pacific coast timber would be that the sap cannot possibly be extracted by this method nor the timber mechanically seasoned or dried. When live steam is turned into a large retort containing a charge of piles, or lumber, it can readily be understood that the steam condenses very rapidly and the heat produced by the steam will undoubtedly increase the absorptive quality of the wood. As a natural result a large portion of the condensed steam will be absorbed by the wood in that state, and we cannot understand how the water or natural sap contained in the lumber can be extracted by the vacuum applied to the retort. On the other hand, if dry heat through steam coils is applied for the purpose of drying out the water from the lumber, it seems clear that such a heat will only have the tendency to still further destroy the cohesion of the fibers.

We agree with Mr. Beal, of the Southern Pacific Co., as to the best method of extracting the sap and water from piles or lumber during the process of creosoting; namely, by submerging the load in creosote within the retort and bringing the temperature of the oil to 212 to 220° F. The oil itself (being a distillate produced at a higher temperature) will not boil, but the water contained in the timbers being subjected to that temperature through the oil will evaporate and this vapor will pass off freely through the condenser. We find that treated by this method this class of lumber has its strength and elasticity preserved and rarely shows any signs of checking. Piles thus treated become harder than in their natural state, while those treated by the steam vacuum process become soft and spongy and brittle.

We are at the present time engaged in making some experiments with timbers treated with crude petroleum containing an asphalt base. After about 14 months' submersion in salt water we removed some untreated lumber and some treated with petroleum, and we found the untreated lumber very badly damaged by limnoria, while that treated with the petroleum was entirely free from any injury. It is now about 14 months since the second submersion in the same place of the same sticks, but we have not yet removed them to ascertain the result. We are strongly of the belief that our California petroleum will be very efficient for the treatment of railway ties and structural timber, as when judiciously manipulated the lighter portion will saturate the heart wood, while the heavier asphaltic body will seal the outer pores. If this should prove to be the fact, it would prove quite advantageous for the Pacific coast, where the crude oil is abundant and cheap, while creosote (in consequence of necessary transportation cost) is very expensive.

*Extract from a paper read at the annual meeting of the Wood Preservers' Association, Chicago, Jan. 16, 18.
†Manager, Puget Sound Timber Preserving Co., San Francisco, Cal.

REINFORCED CONCRETE SUBWAYS: CHICAGO, BURLINGTON & QUINCY RY.

In connection with the construction of its new freight yards at Galesburg, Ill., the Chicago, Burlington & Quincy Ry. has built two subways to carry streets across under the yards, and these subways are of special and interesting design.

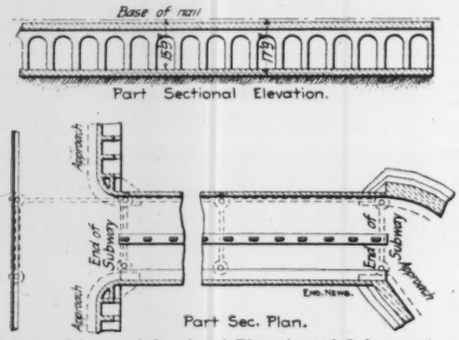

Fig. 1. Plan and Sectional Elevation of Subway at Galesburg, Ill.; Chicago, Burlington & Quincy Ry.

They are of rectangular section, built of reinforced concrete and divided into two sections or roadways by a central wall pierced with arches.

The subway for the Lemon's Corner Road crosses the tracks at an angle, and is 422 ft. long between portals, with inclined approaches of 5% grade. At one end there is a single approach, 233 ft. long, almost at right angles to the subway; at the other end there are two approaches at right angles to the subway, making a T-shaped arrangement, as shown in the plan Fig. 1. The subway has two openings, 13 ft. wide and 12 ft. 6 ins. high, one of which is divided into a 3-ft. sidewalk and a 10-ft. roadway. The details of the design are clearly shown in the sectional drawings in Fig. 2. The driveways of the subway and approaches are paved with two layers of brick on a gravel cushion bed; the bricks are laid flat for the bottom course and on edge for the upper course. The sidewalk is given a cement finish. A 12-in. tile drain is laid below the footing of the wall at one side and connected to concrete catchbasins at each end of the subway, the water being carried off by a 12-in. sewer of considerable length, built for this special purpose.

The retaining walls of the approaches are of solid section up to a height of about 12 ft. 6 ins., and beyond that they are of abutment section. The details of these walls are shown in Figs. 3 and 4. Near the top the ground is sloped off on the outer side, instead of using a wall. There is no sidewalk on the approaches, but the outer side of the roadway has a Z-shaped combination curb and gutter of concrete, Fig. 5. The object of the lower leg (between the gutter and paving) is to prevent the rush of water down the steep grade from washing out the cinder filling upon which the gutter is laid. The width between curbs is 26 ft., and the paving is the same as in the subway.

The Thirwell Road subway is 420 ft. long, with 5% approaches forming a straight line with it. Its construction is practically identical with that of the one already described.

In all this work a gravel concrete is used, made with gravel taken directly from the pit and not screened or graded in any way. This gravel is very clean and uniform, and care is taken to prevent getting any clay with it. The mixture is approximately 1 to 6, requiring 1½ barrels of cement per cu. yd. of concrete for the roof and 1¼ barrels for all other concrete. The concrete is made very wet and is poured in like water, thoroughly filling the forms and surrounding the reinforcing bars. Concrete made in this way is found to be very dense. The forms are of matched lumber, not lined, and the only attempt at facing the exposed surfaces is to work the face of the concrete with a hoe, so as to press back the stones and show a cement facing.

The Lemon's Corner Road subway was built by the railway company's bridge and building department, while the Thirwell Road subway was built by Mr. J. O. Heyworth, of Chicago. For drawings and particulars of these structures we are indebted to Mr. C. H. Cartlidge, Bridge Engineer of the Chicago, Burlington & Quincy Ry.

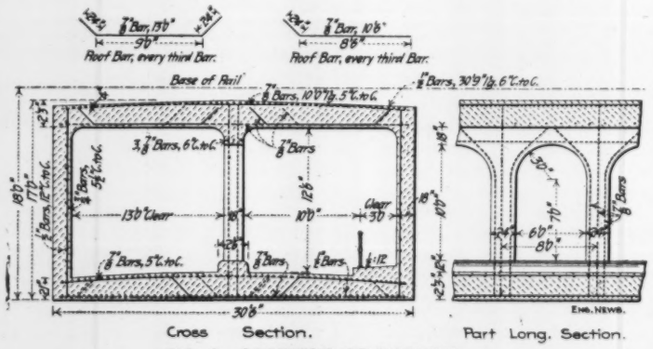

FIG. 2. SECTIONS OF SUBWAY.

TWENTIETH ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS AT TORONTO, ONT.

During the nineteen years since the Canadian Society of Civil Engineers was founded it has held all its meetings at Montreal, its headquarters. The twentieth annual meeting, held last week at Toronto, Ont., was the occasion of the first departure from the custom. The meeting was markedly successful in point of attendance, nearly two hundred being registered, and will doubtless encourage the management of the society to abandon definitely the stay-at-home policy.

There are indications, also, that the meeting will lead to the formation of a branch of the society at Toronto. Such a branch has been long talked of, and within the last two years definite steps were taken by a number of Toronto members to form a branch. For some six years a flourishing technical club, the Engineers' Club of Toronto, has been in existence, and the promoters of the local branch scheme desired to use this club as the nucleus of the branch. The club did not accept the proposals made, and the branch idea was dropped. The meeting of last week gave it new stimulus, however, and steps may soon be taken, by petition of ten members, as the society's constitution requires, to establish the Toronto branch. At the society's banquet, held at the King Edward Hotel on the evening of Thursday, Feb. 1, several speakers expressed their convictions in favor of such an organization, though they agreed that it should be quite independent of the Engineers' Club.

The meeting of last week extended over four days, Tuesday, Jan. 30, to Friday, Feb. 2, inclusive. Rather more than half the available time was devoted to visiting places of technical interest at Niagara Falls and in Toronto, and this was perhaps the most valuable part of the meeting to the majority of the attending members. Wednesday, Jan. 31, the second day of the meeting, was given up to an excursion, by special train on the Grand Trunk, to Niagara Falls, where the three companies building power plants on the Canadian side received the society and threw open their plants for its inspection. The Ontario Power Co. welcomed the guests immediately on their arrival, showed them through its generating station and its transforming and switching station, and then entertained them at "lunch," or, rather, at an elaborate banquet. Gen. F. V. Greene, President of the company, made a brief address, as did also Mr. J. W. Langmuir, of the Queen Victoria Niagara Falls Park Commission, and Mr. P. N. Nunn, Associate Chief Engineer of the plant. The society then visited the tail-race tunnel and the power-house of the Electrical Development Co., the power-house of the Canadian Niagara Power Co., and the elaborate headworks of the Ontario Power Co. Friday was also employed for technical excursions. Most interesting among the places visited were the transformer station of the Toronto & Niagara Power Co., which is the receiving station of the 60,000-volt transmission line of the Electrical Development Co., and the plant of the Canadian Foundry Co., at which latter the society was entertained at lunch.

The following were elected officers of the society for the coming year: President, H. D. Lumsden, Ottawa; Vice-Presidents, M. J. Butler, of Ottawa; C. B. Smith, of Toronto, and W. M. Walbank, of Montreal; Councillors, W. F. Tye, of Montreal; John Galbraith, of Toronto; Duncan Macpherson, of Ottawa; Phelps Johnson, of Montreal; W. H. MacLeod, of Winnipeg; G. H. Webster, of Manitoba; R. McColl, of Halifax; H. Holgate, of Montreal; John Kennedy, of Montreal; C. Fergie, of Sydney, C. B.; E. A. Hoare, of Quebec; J. S. Dennis, of Calgary; E. Mohun, of Vancouver; R. A. Ross, of Montreal; L. A. Herdt, of Montreal; R. J. Durley, of Montreal; J. E. Hardman, of Montreal; J. B. Porter and J. G. G. Kerry, of Montreal.

The technical proceedings included a strong appeal to the Dominion Government for better and more effective conduct of public survey work. At the present time each department and bureau does its own surveying, as occasion requires, and without knowledge of the work of other departments and without heed to whether the same ground may have been already covered; and, due to the lack of reference points and benchmarks, the work of the different bodies is generally without co-ordination. The first thing needful for bettering these conditions is a central record office to bring together and make available the results of the several departments' surveying. Following this, a complete geodetic survey of the Dominion is demanded, and the beginnings of a topographic survey. The society passed the following resolution:

Resolved, That the council be instructed to represent to the Dominion Government the importance of co-ordination of the various surveys conducted by its departments, and the adoption of such methods as will secure permanent records, both in the field and in the office, of all such work. In the opinion of this meeting, the complete working out of a scheme will involve very careful study, not only of the valuable work now being done in Canada, but also of the methods which have been adopted by the Governments of other countries, and should lead to the establishment of a general topographical and geodetic survey scheme for the whole Dominion.

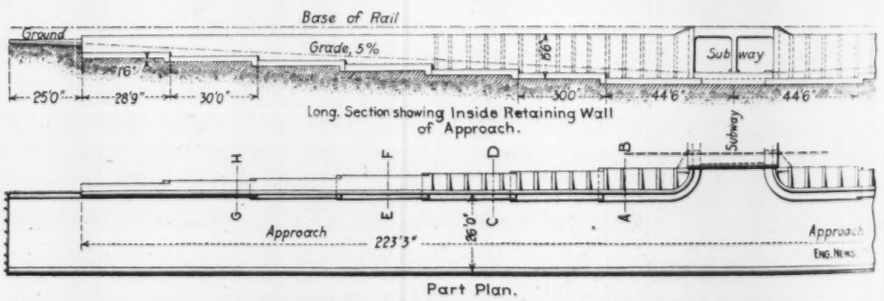

FIG. 3. PLAN AND ELEVATION OF RETAINING WALL.

A resolution also was passed which expressed the growing need for systematic forestry, and urged that steps toward this be taken by the government as soon as possible.

The following papers were read at the meeting: "Diamond Mining at Kimberley, South Africa," by Prof. J. B. Porter, of Montreal; "Tide Levels and Datum Planes on the Pacific Coast of Canada," by W. B. Dawson, of Ottawa; "Hydraulic Locks on the Trent Canal," by W. J. Francis, of Peterborough; "Experience with Conduits in Toronto, with Notes on the Laying of a Six-Foot Steel Pipe," by C. L. Fellowes, of Toronto; and "The Origins of Our Canal System," by E. Marceau, of Montreal, this last being the Presidential address.

The address of Retiring President Marceau described, in as much detail as the fragmentary records make possible, the early canal construction in Canada. The first recorded bit of canal work was a canoe-channel about one mile long between the St. Lawrence River and Lake St. Pierre, a small body of water on the Little River St. Pierre, halfway between Montreal and Lachine. This channel was started by a religious order in 1700. With this exception, the first Canadian canals were built by the British army engineers, beginning in 1779; these were short canals on the St. Lawrence, serving as bypasses around rapids. Another beginning was made in 1798 at Sault Ste. Marie, where the North-West Company built a canal half a mile long, with a lock 38 ft. long, 8 ft. 9 ins. wide, for 9 ft. lift. The present canals of Canada are summarized in the following table:

CANALS OF CANADA.

ST. LAWRENCE RIVER ROUTE.

	Dimensions of locks.	Water on sills.
Lachine, Soulanges, Rapide Plat, Cornwall, Farrans Point, Galops, Welland	270 ft. × 45 ft.	14 ft.
Sault Ste. Marie	900 ft. × 60 ft.	20 ft.

RICHELIEU RIVER ROUTE.

	Dimensions of locks.	Water on sills.
Chambly	118 ft. × 22 ft. 6 ins.	7 ft.
St. Ours	200 ft. × 45 ft.	7 ft.

OTTAWA RIVER ROUTE.

	Dimensions of locks.	Water on sills.
St. Annes, Carillon, Grenville	200 ft. × 45 ft.	9 ft.
Rideau	133 ft. × 32 ft.	5 ft. 6 ins.
Culbute (abandoned).	200 ft. × 45 ft.	6 ft.
River du Lièvre, 1886.	160 ft. × 32 ft. 7 ins.	8 ft.

The paper of Mr. W. J. Francis, describing the two hydraulic lift locks at Peterborough and Kirkfield, on the Trent Canal, dealt with work of much interest, but, like the other papers, it received no discussion. The two hydraulic lifts are the first built on the American continent; there are three canal lifts of this type in Europe. The Peterborough lift is the larger of the two, having 65 ft. lift against 50 ft. lift at Kirkfield. The dimensions of the lock-chambers in both cases are 140 ft. × 33 ft. × 8 ft. depth of water. The chambers, of which each lock has two, side by side, are supported each on a central hydraulic plunger, working in a vertical cylinder set in the ground. The two cylinders of the lock are connected by a pipe fitted with a valve, so that one lock-chamber descends while the other ascends. Overbalance is obtained by filling one chamber deeper than the other. The chamber gates are hinged along the bottom and are operated at Peterborough by a pinion meshing with a segmental rack, at Kirkfield by a system of levers. The joint between chamber and breast wall is made by a rubber tube inflated by air. The fixed construction, including breast-walls, wing-walls, pits, and guide-towers, are built of concrete, except that at Kirkfield structural steel towers are used. The concrete construction involved some very careful work, as, for example, the breast-wall requires to have its outer face truly plumb and straight to avoid interfering with the movement of the lock-chamber.

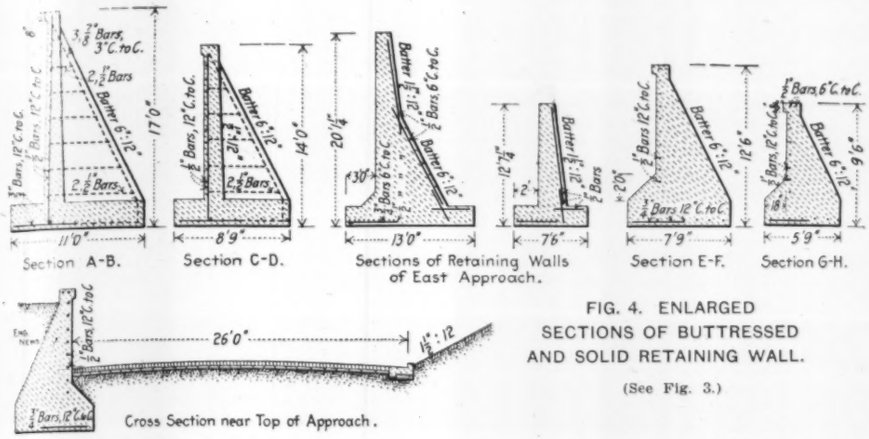

FIG. 4. ENLARGED SECTIONS OF BUTTRESSED AND SOLID RETAINING WALL.

(See Fig. 3.)

The 90-in. plungers of these locks are of cast iron, the cylinders of cast steel, both in 5 ft. 3 in. lengths. A most interesting part of the paper described hydraulic tests made upon the cylinder sections before installation. The working pressure in these cylinders, which are 92½ ins. in inside diameter, is 600 lbs. per sq. in. The tests were carried up to 1,200 lbs., in some cases to 2,000 lbs., and in one case to 2,200 lbs. per sq. in. The 2,000-lb. pressure stressed the metal nearly to its elastic limit. The pressure of 2,200 lbs. stretched the section by 1½ ins. on the circumference, at the middle of its length, and after releasing the water pressure a stretch of 1 3-16 ins. remained as permanent set. The extensions in all the tests were measured by five steel tapes encircling the cylinder at equal intervals; the ends of each tape were lapped and fitted with a vernier reading to 0.01 in., which was sufficiently accurate, as the circumferential test length was about 300 ins. Under the pressures used in these tests the steel castings proved to be absolutely water-tight; the cast iron (plunger) sections sometimes showed a slight percolation, but this always stopped after the sections were allowed to stand for a day or two filled with water under 40 lbs. air pressure.

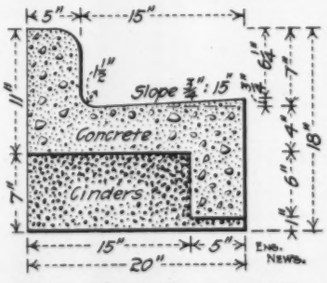

Fig. 5. Concrete Curb and Gutter.

The paper of Mr. Fellowes related some of the troubles which have been encountered at Toronto in maintaining intake pipes which extend out into the lake from the water-works pumping station. The most recent work on the intake was the construction of a 6-ft. submerged steel pipe across the island which closes off Toronto Harbor. This pipe is laid on two-pile bents. The bents were framed up on the ground, and were then sunk by water jet aided by a 2,000-lb. pile-driver hammer resting on the cap over each of the two piles of the bent. The bents were sunk by jetting to within 6 ins. of correct level, and were then driven to place by the drop-hammers. A special two-hammer pile-driver was built for the work of setting these bents. The conduit itself is of ½-in. steel, riveted in 60-ft. lengths; the joints are made by 5 × 5 × 1-in. angle flanges bolted with 44 1¼-in. bolts and sealed by lead gaskets. The pipe sections were lowered to place from a specially-built scow and were bolted up by divers. The scow was made of two 60-ft. sections of the pipe, closed off by temporary heads, and held some 7 or 8 ft. apart in the clear by timber saddles; a head-frame over these saddles carried hand winches by which the pipe sections could be lowered. The sections received from cars on shore were fitted with temporary heads, launched and floated into the scow, which was anchored over the working point; the heads were then taken off, the section lowered on the winches, and jointed to the previously-laid section. The trench for the pipe was required to be dredged 2 ft. below the grade of bottom of pipe, except at the joints, where 5 ft. clearance was required to allow proper bolting and inspection.

"Tide Levels and Datum Planes on the Pacific Coast of Canada," by Mr. W. B. Dawson, was read by title only. It gives the results of a thorough search into the reference planes which have been used for hydrographic and other surveys on the coast section in question. As every new survey in that region appears to have used an independent datum plane, the difficulty of co-ordinating the existing tide records is apparent. The present paper gives the relative elevations of the various reference planes now or previously used at Victoria, Esquimalt, Vancouver, Port Simpson, New Westminster and a number of other coast points. A large number of registering tide gages have been established along the coast, and from their records it will be possible to compute the Mean Tide Level at the several stations, as well as to give tidal data for the use of mariners.

ACCURACY METER TESTS AT CHICAGO, made in June, 1905, but just brought to our attention, showed creditable results. Ten Pittsburg meters of each of eight different sizes, which had been in continuous operation from 5 to 6½ years each, were tested, with the results shown by the following table:

Size, ins.	Length of service.—Yrs.	Mos.	Total registration, cu. ft.	Percentage of Accuracy. *Small stream.	Intermediate stream.	Full meters.	Av. for 10 meters.
⅝	6	1	49,000	94	100	99	99
¾	6	8	220,000	101	98	98	100
1	6	6	400,000	102	100	100	101
1½	5	4	1,107,000	97	101	100	100
2	6	3	2,661,000	96	99	99	100
3	5	.	5,321,000	99	100	100	99
4	6	4	8,238,000	102	101	100	101
6	5	1	45,376,000	†100	100	100	101

*1-32-in. on the ⅝-in. size; ⅛-in. on the ¾-in. size; ¼-in. on the 1-in. and 1½-in. sizes; ½-in. on the 2, 3 and 4-in. sizes; and 1-in. on the 6-in. size.

†This 6-in. meter was also tested on a ½-in. stream, at which it showed a registration of 92%.

All meters tested under 30 lbs. pressure.

The meters were tested in the condition in which they were on removal from their connections.

THE DETROIT RIVER TUNNEL PLANS have been completed by the engineers of the Detroit River Tunnel Co. and bids will be received until March 8 for the construction of the work. The tunnel will give passage to the lines of the Michigan Central R. R., which now transfers its cars by ferry, and the tunnel company is an organization in the Vanderbilt interests for the construction work only. The length of the tunnel between approaches will be 7,800 ft. and it will consist of parallel twin tubes each carrying a single truck. The specifications provide for four alternative methods of construction and bidders are also left free to present plans of their own should they choose. Bids are being received by the Detroit River Tunnel Co., Grand Central Station, New York City. A full description of the work will appear in our next issue.

MUNICIPAL STREET RAILWAY CERTIFICATES to the amount of $75,000,000 will be voted upon soon at Chicago. Ordinances providing for the issuance of such certificates under the Mueller law have been passed by the city council and approved by Mr. E. F. Dunne, Mayor of Chicago. A legal contest is expected before the bonds, if voted, are issued.

SEPTIC TANK AND SAND FILTERS AT DOWNER'S GROVE, ILL.*

By W. S. Shields.†

The village of Downer's Grove is 21 miles from Chicago and has a population of about 3,000. A water supply system from two deep wells operated by an air-lift was installed in 1894. The topography is such that there was little choice of location for the disposal works, which was placed a quarter of a mile west of the village limits and some 2,000 ft. from the nearest residence. Here 4.5 acres were purchased for $3,500. The land is of uneven surface and contains banks of gravel. A small creek crosses the disposal area and passes up through the village from west to east and in order to get the lateral sewers from the south side of this creek across into the main sewer which parallels it on its north side, it was necessary to use a flat grade; and even with 3,000 ft. of 18-in. sewer at a 0.10% grade, it was possible only to get 4 ft. of fall with which to operate the disposal works.

The small available fall and the presence of gravel were conditions which governed in the selection of sand filtration, following septic treatment. The entire cost of land, plant and sewers was raised by special assessment.

The disposal plant consists of a septic tank and six sand filters, each filter having 1,800 sq. ft. of filtering surface, making a total of ¼ acre.

SEPTIC TANK.—The tank (Fig. 1) has a cubical capacity of 64,000 gallons when filled to its flow line. Its flat concrete roof has a sidewalk surface with iron manhole frames set in the concrete. A grit and overflow chamber forms the entrance to the tank, with a by-pass around to the outlet drain. Two concrete scum walls extend down from the roof into the tank.

AUTOMATIC CONTROLLING CHAMBER.—From the septic tank the sewage flows over a weir the full width of the tank into a concrete trough, and thence (Fig. 1) into a controlling chamber, also of concrete. From this chamber six tile pipes, 15 ins. diameter (three on each side), lead to the six filters. Each pipe is provided with a 16-in. direct lift Coffin sluice valve and frame set in the face of the concrete wall at an elevation of some 6 ins. below the outlet weir of the septic tank. A seventh gate, provided with a screw stem and wheel, is so placed that when opened the water will flow through the chamber direct into the outlet. The chamber is 10 ft. square inside and surrounded with a building constructed of paving brick and covered with an ornamental tile roof; the floor is of concrete. In this chamber are two small compartments, with concrete walls, one designed for an upward filter and the other for a compression chamber; the former is connected by a 4-in. pipe with the septic tank in such a manner that the water enters at the bottom and filters upward to the surface, where it flows through a pipe and valve into the compression chamber. Both of these chambers are provided with drain pipes leading into an outlet chamber outside; into this the filtered effluent from all the beds enters, and from it all water passes through the outlet pipe into the creek. [The small upward filter, as we understand it, is used simply to clarify enough tank effluent to separate the controlling works.—Ed.]

Owing to the fact that the flow from the septic tank to the filters must be controlled without any loss of head, automatic valves were used, the gate parts of which have already been mentioned. The operating portion (Fig. 2) consists of a cup vessel partly filled with liquid, and another cup inverted and placed inside of the first on the principle of a gasometer; the outer cup is provided with suitable supports and the inner or lifting dome, when not raised, rests on the bottom of the cup. Two pipes enter the cup from the bottom, one, terminating just below the liquid seal line, admits air; and one, above the liquid line, provides a means for releasing the air. Extending from the bottom of the cup is a tube through which passes the stem of the gate to be lifted, and a similar but larger tube is placed ing dome, allowing it to rise and fall freely inner tube of the cup. The stem of the tached to the lifting dome by means of a y The inlet air pipe is carried up outside a point well above the liquid seal level, then is connected with the compression dome, paratus is ready to be operated. The o brought about by air compressed by mean dome so placed in the small compression ch as the chamber fills with water it creates upon the air confined in the compression it forces the trap to the lifting dome and gate. A small siphon is placed in the chamber in such a way that, when the va the siphon is put into operation and the emptied, allowing the compression dome to refill

The operation of the valves in rotation is e small copper chains attached to the top of the and working over pulleys in the ceiling; the chains are furnished with counterweights, and are so arranged that when a gate is raised two counterweights drop, each opening an air cock interposed in the piping system, one of which releases the air from the next valve opened and allows the gate to close by its own weight, while the other opens a similar cock in the feed pipe, by which the next charge of air is directed to the valve next to be operated; these air cocks remain open until the gates drop, raising the chains and closing the cocks. The period of time in which each filter is to receive the flow is regulated by the admission of water into the compression chamber.

It is expected that the water mains will soon be extended within piping distance of the plant, when water from that source can be utilized to operate the compression chamber. At present it requires approximately 100 gallons of septic effluent for each operation, but this might be reduced to 50 or 60 gallons if found necessary.

FILTER BEDS.—The filter beds are formed in natural excavation and embankment; the underdrains are of 6 and 8-in. sewer pipe, laid with open joints. The outer ends of these drains are extended vertically to a level above the surface of the beds and capped with iron ventilators.

The filtering material was obtained from a bank near the works, washed and screened, and deposited in place by wheelbarrows. There are 12 ins. of coarse gravel, with 9 ins. of a finer grade on top; then 9 ins. of still finer gravel, and on top of this is spread 6 ins. of washed torpedo sand. The distribution is by means of wooden troughs, a main trough feeding branch troughs having openings on each side.

COST.—The system was completed in September, 1896, and there have been some 115 houses connected to the system, but the amount of sewage is not yet sufficient to test the efficiency of the plant. Mr. F. G. Mortimer, of Glencoe, Ill., was general contractor for the entire work, which was completed and paid for in 5% special assessments bonds. The excavation was mostly hard clay with many granite boulders bedded in it, making it undesirable for machine digging.

The entire cost of the system amounted to $54,835, and this includes the land, disposal works, sewer system, and administrative cost of every kind. The cost is divided as follows :

Land and right of way	$3,500
Disposal works complete	8,500
Sewers:	
19,120 ft. of 8-in., cut 8.0 ft., at $0.53	13,427
6,355 ft. of 10-in., cut 11.0 ft., at .76	4,829
3,118 ft. of 12-in., cut 8.5 ft., at .76	2,369
3,324 ft. of 15-in., cut 12.0 ft., at 1.26	4,188
3,017 ft. of 18-in., cut 12.5 ft., at 1.56	4,705
206 circular brick manholes, at $28.90	5,953
176 cu. yds. rock excavation, at $3	528
Sundry extras on sewer system	270
Engineering and inspection	2,500
Legal and administration expenses	1,436
Total	$54,835

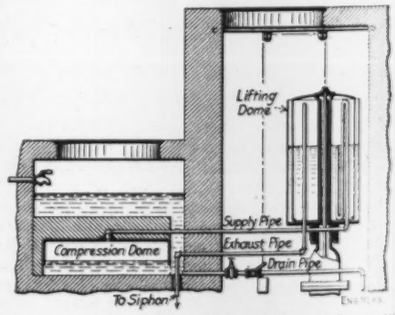

Fig. 2. Sketch to Illustrate Operation of Controlling Apparatus for Automatic Sewage Bed Dosing Valves.

(This does not show the exact arrangement at Downer's Grove, Ill., but illustrates the principle involved. Ed.)

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors; Rockford, Ill., Jan. 17, 19.

†Consulting Engineer, Marquette Building, Chicago.

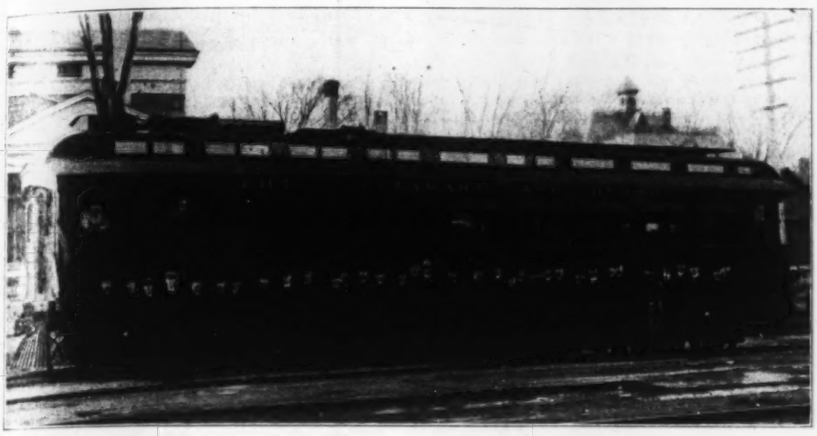

FIG. 1. VIEW OF EXPERIMENTAL GASOLINE-ELECTRIC CAR TESTED FEB. 3 ON THE DELAWARE & HUDSON R. R.

While the cost of the disposal works is probably fair for that class of work, the cost of the sewer system for similar excavation is probably 10% too low for profitable contracts.

In connection with this work some 2,000 ft. of 48-in. concrete storm water sewer was constructed. The concrete was not reinforced and was put in place in the trench, which averaged 6 ft. in depth. The shell of the sewer is 8 ins. thick. The invert is plastered with Portland cement. The work was completed, making a very satisfactory piece of construction, at a cost of $4.80 per lin. ft.

TEST OF A GASOLINE-ELECTRIC MOTOR CAR.

The accompanying illustrations show a railway car carrying a gasoline engine which drives an electric generator furnishing current to electric motors geared to the driving wheels. This car has been recently designed by the engineers of the General Electric Co. in conjunction with the staff of the American Locomotive Co., at Schnectady, N. Y., and an experimental run from Schenectady to Saratoga, N. Y., was made over the tracks of the Delaware & Hudson R. R. on Feb. 3. As indicated by Fig. 1, the car is of the combination type, comprising a passenger compartment, smoking room, a baggage room, engine room, one toilet and a motorman's compartment. It is 65 ft. long over buffers and weighs, equipped, 65 tons. A complete controller equipment is located at each end of the car, the forward controller being located in the engine room, while the rear compartment is self-contained. The car has seating capacity for 40 passengers, including seats for 12 in the smoking room. In general, it is built on the lines of a standard D. & H. passenger coach.

The gasoline engine for this car was built by the Wolseley Tool & Motor Car Co., Ltd., of Birmingham, Eng., and is considered the most powerful unit yet constructed for this class of work. It develops 160 B. HP. when running at 450 r. p. m. The cylinders are horizontal opposed, six in number, 9 ins. diameter and 10 ins. stroke. All valves are mechanically operated, and the cylinders are water-cooled. Hitherto difficulty has been experienced in starting internal combustion engines of this size, but in the present case this has been entirely overcome by using shells filled with black powder to provide the initial charge in one cylinder. On starting the engine the shell is fired by a hand trigger, the whole being similar to the breach mechanism of a gun. Jump sparks and low-tension ignition are both provided, current being furnished to the latter by a small magneto driven from the engine shaft.

The volatilization of the liquid fuel is produced in two carburetors which form an integral part of the engine. Each carburetor supplies three cylinders, and is equipped with two float-feed chambers. The chambers are identical, and are of the usual needle-valve type. Very flexible arrangements are provided to govern the air supply, so that it may be taken from the atmosphere or from the crank chamber, or from both, according to the temperature required. The mixture is heated to the required temperature in a small chamber, which itself is warmed by the exhaust. The lubrication is especially thorough, being force-feed for main bearnigs and pistons and drip-feed for all other working parts. Gasoline is stored in steel tanks beneath the car, and the burnt gases pass through the roof into mufflers, from which they exhaust into the air. The cooling system for the cylinders consists of two sets of radiating tubes located on the top of the car. Water for cooling is contained in the engine base. For heating the car a three-way cock is provided which by-passes the circulating water through the usual pipe-heating system within the car.

Coming now to the electrical equipment, the main current is furnished by a 120 KW. direct-connected General Electric six-pole unit, designed for 600 volts. This generator is provided with commutating poles, which, in connection with the method of voltage control, furnishes a very flexible operating system. The advantage of commutating poles is evident when it is considered that the field excitation at starting is weak, and the large current at low voltage is required to give the necessary starting torque at slow speeds. Owing to the peculiar operating conditions of this system, the generator, while retaining the characteristics of a shunt-wound machine, is separately excited by a 5½-KW. two-pole compound-wound exciter working at 110 volts. This is located on top of the generator and is driven by a Morse silent chain.

There are two G. E. 69 motors of standard railway construction similar to those used on the Interborough system in New York City. For regulating the speed of the motors, as mentioned above, voltage control has been adopted; in other words, the speed of the car is governed by varying the field strength of the generator. With this method the speed of the engine remains constant after acceleration. The controller is semi-automatic, and can be set for any predetermined maximum acceleration. It is arranged for series parallel control, the motor connections being changed from series to parallel by the reversing handle. This latter has five positions—"series ahead," "parallel ahead," "off," "series reverse" and "parallel reverse." Arrangements are provided to prevent the motor connections from being changed from series to parallel until the resistance is put into circuit.

Further operating details comprise a General Electric combination straight and automatic air brake equipment and a special lighting equipment. Meridian lamps are used, equipped with Holophane reflectors, the whole affording a very satisfactory system for car lighting. The headlights are supplied with 100 c. p. incandescent lamps of the stereopticon type, one for each end of the car. The trial trip demonstrated the practicability of this car equipment, and was entirely satisfactory to the engineers of both companies, so far as the tests indicated. While the car was not designed for high speed, the average running time was 35 miles per hour, and several times the car attained a speed of 40 miles per hour.

We are indebted for the above information to the General Electric Co., of Schenectady, N. Y.

A NEW STATE ROAD LAW is proposed for Maryland. Under it an annual appropriation of $200,000 would be available for division, on application, between the several counties of the state, in proportion to their respective mileage of public roads, provided as much money was raised locally as was granted by the state. Apparently the work would be done by the counties, but under the supervision of a State Engineer.

A SHIPBUILDING CABLEWAY of 505 ft. clear span is in use at the yards of the Palmer Shipbuilding Co., Jarrow, England. It carries three distinct lines of cables, the maximum spacing between the outer lines being 100 ft. The steel head frame at each end consists of two inclined built-up columns carrying a transverse trussed girder, upon which run the end carriages of the three cables, the cables being thus able to serve any point within the 100-ft. width. The head frames have an inclination of about 57° and are mounted on heavy shoe pins or hinge pins. On each cable runs a 3-ton hoisting trolley, the operator of which controls the hoist, the

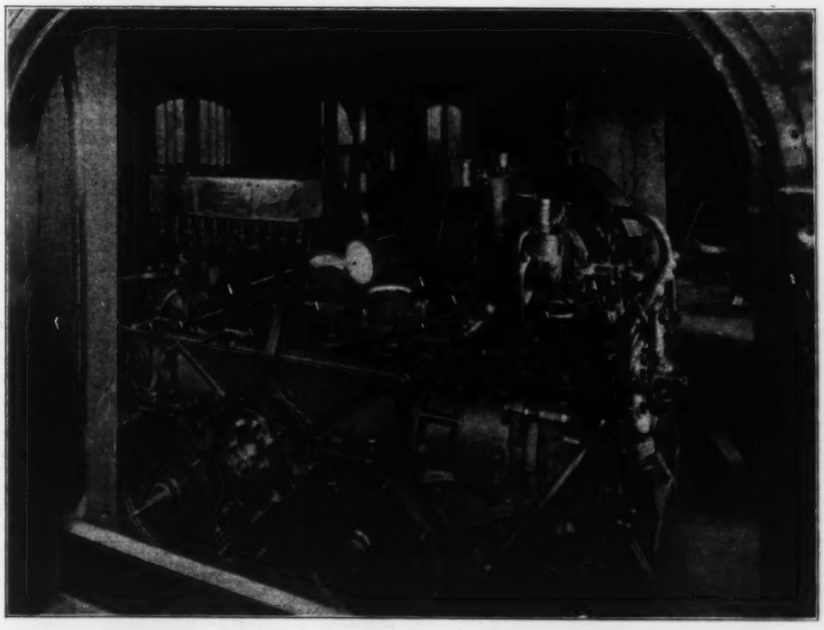

FIG. 2. VIEW SHOWING ENGINE AND GENERATORS, GASOLINE-ELECTRIC CAR.

longitudinal travel of the trolley, and the transverse travel of the end carriages. All operations are effected by three-phase electric motors, and the speeds are 150 ft. per minute for the hoist, 600 ft. per minute for the trolley, and 400 ft. per minute for the end carriages. The battleship "Lord Nelson," 406 ft. long and 79 ft. beam, is now being built on the berth served by this cableway. The company has also decided to build a similar cableway to serve two other berths; this will be 750 ft. long, and with six lines of cables, three for each berth.

ELECTRIC TRACTION IN THE SIMPLON TUNNEL will be on the three-phase system with a current of 3,000 volts, as already employed in Italy on the Val Tellina Railway. It is stated that trains of 350 to 400 tons will have to be handled at a speed of not less than 25 miles per hour up grades of 2¼%, this speed being maintained by steam locomotives on the steep and crooked line of the Gotthard Railway. The electric locomotives now in use on the Val Tellina line are of the 2-6-2 type, weighing 62 gross tons, with 42 tons available for adhesion. Two such engines would be required on the Simplon Ry., and while these together would be heavier than the steam locomotive for similar service, there would be many advantages in their use. A contract has already been made for the electrical equipment of the section between Brieg and Iselle for experimental service previous to the opening of th tunnel itself for traffic.

LABOR during the coming season promises to be higher in price and more difficult to obtain even than last year. The stringency is particularly felt in the West, where the large amount of railway construction work with the activity in mining and the large amount of Government contract work, has created a demand for more labor than is available. It is stated that railways in the Northwest could use 30,000 additional men if they were available.

PERSONALS.

Mr. A. E. Sweet has been appointed assistant to the second vice-president of the Chicago, Rock Island & Pacific Ry. Co.

Mr. B. B. Lathbury, M. Am. Soc. C. E., has resigned the positions of president and general manager of the Alma Cement Co.

Mr. O. M. Laing has been appointed Assistant Superintendent of the Central New England Ry. Co., with headquarters at Hartford, Conn.

Mr. James A. Storer has resigned as general manager of the Richfield Springs Electric Light & Power Co., to devote his time to his various other interests.

Mr. David E. Evans, vice-president of the Maryland Telephone Co., of Baltimore, has been elected president of this company in place of Mr. H. W. Webb, resigned.

Mr. Warren Bicknell has resigned as president of the Lake Shore Electric Co., to become president of the Cleveland Construction Co., with offices in Cleveland, O.

Mr. F. Ringer has been advanced from the position of resident engineer to that of principal assistant engineer of the Missouri, Kansas and Texas Ry., with headquarters at Parsons, Kans.

Lieutenant Colonel James B. Quinn, stationed at Savannah, Ga., and Major Chittenden, at Sioux City, Ia., both in the Engineering Corps of the U. S. Army, have been interchanged.

Mr. E. Elbert Young, Assoc. M. Am. Soc. C. E., has been appointed engineer and manager of the Healey Sewer Machine & Construction Co., with offices at 438 Park Row Building, New York City.

Mr. C. Brunel Parker, for several years assistant superintendent of the Cambridge, Mass., water-works, has accepted the position of assistant superintendent of the Hackensack Water Co., of Weehawken, N. J.

Mr. George W. Cutting, Jr., formerly Assistant Engineer of the Metropolitan Water and Sewerage Board of Boston, has opened an office for general engineering practice at 15 Lawrence Building, Waltham, Mass.

Mr. H. M. Cryder has resigned his position as Principal Assistant Engineer of the Wabash R. R., to become Manager of the Wm. P. Carmichael Co., Engineers and Contractors, for construction work, Fullerton Bldg., St. Louis, Mo.

Mr. T. F. Salter, for three years Chief Mechanical Draftsman for the C. W. Hunt Co., New York, has severed his connection with that firm to accept the position of Chief Engineer of the North Pennsylvania Iron Works, Philadelphia, Pa.

Mr. Paul Hooker, who has been connected with the public improvement work in Harrisburg, Pa., has been appointed resident engineer on the construction of a twenty-mile section of pipe for the Lynchburg, Va., water-works, under Mr. J. H. Fuertes, M. Am. Soc. C. E.

Mr. William Brokaw Bamford, Assoc. M. Am. Soc. C. E., and William W. Knapp have been elected directors of the New Century Construction Co., Metropolitan Building, New York City, which is making a specialty of residential fireproof work in and about New York.

Mr. Geo. E. Nicholson, President of the Kansas Portland Cement Co., of Iola, Kans., has been elected President and General Manager of the Indian Portland Cement Co., of Neodesha, Kans. Mr. Nicholson also holds the position of President in the Independence, Kansas, Portland Cement Co., of Independence, Kans.

Mr. Frederick R. Slater, Assoc. M. Am. Inst. E. E., who was principal assistant to Mr. L. B. Stillwell, M. Am. Inst. E. E., while the latter was electrical director of the Interborough Rapid Transit Co. of New York City, has resigned from that company, and has opened an office as consulting electrical engineer at 100 Broadway, New York City.

Lieutenant L. M. Cox, M. Am. Soc. C. E., has resigned his position as civil engineer in the United States Navy. He has been connected with the navy department since 1899, and attached to the Bureau of Yards and Docks since July, 1903. His largest important work was superintending the construction of the floating dry-dock "Dewey" at Solomon's Island, Md.

Mr. Rodman M. Brown, Assoc. M. Am. Soc. C. E., for some years with the John S. Metcalf Co., of Chicago, builders of steel and concrete grain elevators, etc., has gone into the concrete contracting business, associating with him Mr. E. M. Read, formerly of the same company, under the firm name of Brown & Read, with offices at 1212 Hartford Building, Chicago.

Mr. E. A. Handy, M. Am. Soc. C. E., Assistant Manager of the Lake Shore & Michigan Southern Ry., has been promoted to the position of General Manager. Previous to last July Mr. Handy was for four years Chief Engineer of the Lake Shore division of this road. He is a graduate of the Massachusetts Institute of Technology and has been in railroad work since 1878.

Mr. J. A. Prescott has been appointed Manager of the St. Louis office of the Blaisdell Machinery Co., of Bradford, Pa., manufacturers of air compressors and of the Jeanesville Iron Works Co., of Hazelton, Pa., manufacturers of pumping machinery. This office will have charge of the entire southern and southwestern territory. Mr. Prescott recently resigned from the Rand Drill Co. as manager of their St. Louis office, after having beer in their service about fifteen years.

Mr. W. G. Hovey has been appointed Construction Manager of the General Railway Signal Co. Mr. Hovey was born in Maine, in 1860. He entered the railway service in 1889 on the New York, New Haven & Hartford R. R. as a lineman in the signal department. In 1890 he went to the Hall Signal Co. as foreman of installation, and two years later was made general foreman of installation. In 1892 he went to the Chicago & Northwestern R. R. as superintendent of signals. In 1900 he went to the Taylor Signal Co. as superintendent, and later was appointed their eastern agent, afterwards being appointed resident manager of the General Railway Signal Co., upon the acquisition by the latter company of the business of the Taylor and Pneumatic Signal companies.

Obituary.

Frederick T. Towne, M. Am. Soc. M. E., General Superintendent of the Yale & Towne Mfg. Co., of Stamford, Conn., died Feb. 4.

Theodore Spencer, vice-president, general manager and a director of the Bell Telephone Co., died recently, at his home 2017 Locust St., Philadelphia, Pa.

John W. Collins, captain of engineers in the Revenue Cutter Service, and assistant engineer in the U. S. Navy during the Civil War, died at Amityville, N. Y., Jan. 26.

Lord Masham (Samuel Cunliffe-Lister), the inventor of many mechanical devices, including a compressed-air brake for railroads and a wool-combing machine, died Feb. 2, at Swinton Abbey, Masham, Yorkshire, Eng.

Mr. Peter McArdle, a civil engineer and railroad contractor, of Dover, N. H., died at Kansas City, Kans., recently. During the Spanish War he was in the employment of the United States, and did considerable engineering work in the Philippine Islands.

John Anderson, water commissioner in Binghamton, N. Y., since 1874, died Jan. 31. It was mainly through the valuable services of Mr. Anderson that Binghamton owns a water-works system complete with filters, free from debt and more than self-sustaining.

Samuel H. Haycock, a Canadian civil engineer, died at Ottawa, Can., Jan. 29, at the age of 51 years. Much of his life was spent in construction work on various Canadian railways, which work included a section of the Intercolonial Ry. Mr. Haycock was also an engineer in the construction of the St. Lawrence River Canals.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21. Annual meeting at South Bethlehem, Pa. Sec'y, R. W. Raymond, 99 John St., New York City.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
Mar. 20. Annual meeting at Chicago, Ill. Sec'y, E. C. Fritch, 1562 Monadnock Blk., Chicago, Ill.

AMERICAN SOCIETY OF INSPECTORS OF PLUMBING AND SANITARY ENGINEERS.—A meeting was held at Washington, D. C., on Jan. 29 to 31 for the purpose of organizing an association of plumbing inspectors and men of allied interests. Officers were chosen, some general features of the organization agreed upon, two papers read, and a constitution adopted, the latter subject to revision at the next meeting, to be held at Cleveland, O., on second Tuesday of January, 1907.

The meeting was called to order by Mr. Henry B. Davis, Plumbing Inspector of Washington, D. C., who initiated the move for the organization. Addresses were made by Messrs. W. F. McFarland, Engineer Commissioner of the District of Columbia, and by Walter Wyman, Surgeon General of the United States. Mr. Davis outlined a plan for the society, which contemplated delegates from State organizations to a national organization; also the appointment of a committee to formulate, in cooperation with the State societies, standard plumbing regulations.

A lively discussion occurred over the scope of the membership, but it was finally decided to limit this to plumbing inspectors, sanitary engineers and others interested, provided they be not actively and exclusively engaged in the commercial or industrial side of plumbing.

The following were the principal officers chosen: President, Henry B. Davis, Washington, D. C.; Secretary, James S. Cassidy, of Boston; Treasurer, Frank W. O'Neill, of Joliet. About 25 delegates were present on the first day, and it was stated that a membership of about 75 had been assured by correspondence.

Two papers were read, one by Mr. F. H. Wright, City Engineer of Helena, Ark., and one by Mr. Chas. B. Ball, M. Am. Soc. C. E., of Chicago, who for a number of years was plumbing inspector of Washington, D. C., and who was subsequently chief inspector of the New York Tenement House Department. Mr. Wright first reviewed the haphazard way in which plumbing inspection work develops in the smaller and in the backward municipalities, regardless of size, and then considered conditions in the lower Mississippi Valley. On the latter point he said:

> I might place the towns in two classes, those in the hills and those in the river bottoms. Most of the habitations are of frame and usually with plenty of yard room. In the small cities and towns there are not many paved streets.
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> As the winters are mild and the summers warm, the better residences are usually set well above the ground on pillars, allowing ample ventilation underneath. This is especially true in the bottom towns. The cheaper class of habitations are called cabins and are occupied by the negroes, who are, of course, the bulk of the laboring class of the south. These cabins are of very cheap construction, and there are usually several on one lot. They are usually supplied with water by a hydrant in the yard common to all.
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> These hydrants in the summer time are of much nuisance unless provided with sinks. Yard closets are of course to be provided for these cabins. In the bottom towns much filling is necessary to get proper drainage, and some difficulty will be encountered in making connection from the laterals at the upper end of the sewer system in order to secure proper grade. The writer has had ridges of earth built to support the pipe and covering in such cases.
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> Plumbing material is expensive in this section on account of the distance from its place of manufacture, and as sanitation should be thorough to be effective the plumbing requirements should have the cost of the work in view, especially where the most of the property is owned by the occupants of small means.
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> In Helena, a city of about 10,000 inhabitants, we have within two years from putting in operation a modern sewer system about 1,000 sewer connections, with modern tested plumbing. Our ordinance as drafted is ambiguous and defective, but the writer as inspector has been allowed considerable latitude by the City Council and Board of Health in using his discretion in matters not properly covered by the ordinance.

An entire morning was taken up by the reading of Mr. Ball's paper, on "A Noteworthy Deficiency in Plumbing Regulations." Mr. Ball stated that the first cities to adopt sanitary regulations were Lowell, Mass., and Providence, R. I., in 1878 and 1881, respectively. Mr. Ball made a comparison between the codes of several cities, treating the subject under various heads and pointing out where they were deficient and where improvement might desirably be made.

Mr. Ball invited discussion, and many of the members spoke at length on various regulations and conditions in the cities which they represented. An especially prolonged discussion took place regarding the use of terra cotta pipe in the limits of houses, culminating in the motion, unanimously passed, that in the judgment of the society terra cotta pipe should not be permitted in the boundaries of buildings or within 5 ft. of the boundaries, but that instead extra heavy cast iron pipe should be used.

The members of the society were received by President Roosevelt, who congratulated them on the formation of such an organization. Members outlined the policy of the society, and the President pledged his support towards the furtherance of plumbing regulations, which he held were identical with the good health of the community.